SCIENTIFIC AMERICAN SUPPLEMENT No. 529

Scientific American Supplement, Vol. XXI., No. 529.
Scientific American, established 1846.

NEW YORK, FEBRUARY 20, 1886.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

GUADALUPE HIDALGO.

THE city of Guadalupe, Mexico, was founded in 1531, at the foot of the Tepeyac Mountain, on the borders of Lake Texcuco. According to an ancient popular tradition, the Virgin Mary appeared to a young native named John Richard Quanhtilan, on the evening of December 9 in the above year, and made known to him her desire that a temple should be erected on that spot, which was thereafter venerated as being under the protection of our Lady of Guadalupe. A collegiate church was erected, a beautiful city was built, and for over three hundred years the shrine has been much resorted to in pilgrimage. The war between Mexico and the United States was concluded by a treaty of peace signed at Guadalupe on February 2, 1848, by which California and New Mexico were ceded to the United States.

PANORAMIC VIEW OF THE CITY OF GUADALUPE, MEXICO.

THE OLD CITIES OF THE NEW WORLD.

THE PALACE OF KABAH.—LORILLARD CITY.

AMONG the edifices of Yucatan there were some that were simple, and others that were rich in decoration. The simplest and severest date back, according to the logic of the art of history, to the more ancient epoch, and the richest to the more modern. The city of Kabah must have belonged to the modern epoch. What remains of the front of the palace demonstrates that it must have been of an incomparable richness in its entirety. We remark in it a double frieze inclosed between three jutting cornices whose ornamentation consists of those great figures superposed three by three that we find distributed in various ways over all the edifices of Yucatan.

The ornamentation of this palace is carried to prodigality, and architecture disappears in order to give place to decorative motives. But it is impossible not to admire the beautiful cornices which frame the friezes, and which are of exquisite workmanship, and would not spoil any of the most beautiful of our own monuments. And yet we have here but a fragment; the ruined state of the edifice does not permit us to judge of the whole, which must have been of the most extraordinary character, the formidable decoration extending over a front of 175 feet. Moreover, the interior and exterior of the monument were painted, polychromy having been employed among the people of Yucatan as among those of the Old World. With them, painting was never to be separated from architecture, and these two arts lent each other mutual aid. With them, as in antiquity, external decoration was the foremost thought of the artist, and this painting, these bright, dazzling colors, distributed with art over the broad facades, amid the entangled mass of monstrous figures, must have singularly added to the wild magnificence of the palace

As for the history of Kabah, upon which writers are silent, we possess a few datum points that will permit us to reconstruct it. We know, in fact, that Yucatan, upon the arrival of the Spaniards, was divided into independent principalities—a sort of feudalism of which each lord had his court. But a century before the conquest (and this is the only document we have) the sovereign of a city called Mayapan reigned over the entire peninsula, that is to say, he had conquered the surrounding provinces, and, as usually the case, had destroyed the capitals of his rivals. The cacique of Kabah was included among the conquered, whom historians designate as the caciques of the Sierra.

The king of Mayapan maintained his authority only through the aid of a Mexican garrison. This gives us a date. We know, in fact, that the Aztecs were tributaries of the king of Azcapotzalco, and regained their independence only under the reign of Izcoatl, about 1425; that they obtained influence, and spread as conquerors over the elevated plains only under the reign of Montezuma; and that consequently they could have sent aid to the King of Mayapan only toward this epoch.

This absolute royalty lasted but a few years, for the yoke of it seemed the harder to bear in that it was maintained by the aid of foreign soldiers. A coalition was formed, and we hear of a people of the *Sierra*, these being the ones that the cacique of Kabah formed part of. A war broke out, and the King of Mayapan was conquered and the city entirely destroyed.

This occurred in 1420 according to Landa, and in 1460 according to Herrera, who, from what we have said above, appears to us to be much the more accurate, and who justifies his chronology in a very victorious way; for, says he, "70 years elapsed between the fall of Mayapan and the arrival of the Spaniards; there were 20 years of abundance and hurricane, 16 years of new abundance and pest, another 15 years of abundance and of intestine war, then a rest of 20 years, the epoch at which the Spaniards came." That makes 71 years, which, dating from 1460, brings us to 1531, and Monteyo occupied Chichen from 1528 to 1531. But as to the modernness of the cities in general, and which would correspond to the fall of Mayapan, Landa will enlighten us upon that.

In one of the chapters of his work, treating "Of the different calamities that Yucatan experienced a century before the conquest," he says: "These populations lived more than twenty years in abundance and health, and they multiplied to such a degree that the entire earth appeared to form but a single city. It was then (between 1440 and 1460) that they constructed temples in so great number that they are to be seen today on every side, and that in traversing the forests we find in the middle of the woods groups of houses and palaces so wonderfully constructed." It not this clear enough?

But we have better evidence still, and the interpretation of the two bass-reliefs that we give (Fig. 1, p. 8441) will convince us. These bass-reliefs, taken by Stephens from a monument of Kabah, of which they formed the door lintels, in our opinion celebrate the victory of the Prince of Kabah and the allied caciques over the King of Mayapan. In fact, they are of the same class as the Tizoc stone of Mexico, in which the warriors, two by two, represent conqueror and conquered, that is to say, the conquests of Tizoc over the neighboring people, who are personified by warriors with curved spines.

What do we see at Kabah?

In one of the bass-reliefs we have a man standing,

richly clad, with a Yucatan head-gear of immense plumes and the celebrated cuirass of quilted cotton. This man is a conqueror, for he is commanding. He is threatening the kneeling man, who is imploring him and offering him his sword. In the kneeling warrior we easily recognize the Aztec soldier with his modester head-gear, which resembles some of those which submitted peoples gave as a tribute to the Mexican conquerors, and such as Lorenzana describes to us in the letters from Cortez to Charles V. The Mexican's costume, aside from his head-dress, is a *maxtli* only. The second bass-relief is more explicit. It has the same two men in the same costume, and in the same attitudes of conqueror and conquered, except that here the conqueror has given up his sword. His entire head-gear shows us the face of a soldier emerging from an animal's head, just as represented in Mexican MSS., and the Yucatanian, who seems to have pardoned the vanquished, is ordering him to leave.

Our two bass-reliefs, then, relate to a battle between the Yucatanians and Mexicans. They narrate the victory of the one and the defeat of the other, and, since we know that Mayapan was the only city where the Aztecs were called upon as auxiliaries, and that, after the destruction of the city, the foreign soldiers received pardon from the conquerors and were quartered in the province of Maxcanu, to the east of Merida, where their race was perpetuated, we can affirm that the two bass-reliefs well narrate to us the defeat of Mayapan, and that, consequently, the monument to which they belonged is posterior to the destruction of the city, and that it would date from 1460 to 1470; *quod erat demonstrandum.*

It will perhaps be thought that we are misusing proofs, that we are heaping them up, and that that suffices. No, it does not suffice, it is necessary to still further support them, and to keep on repeating, for the thing is worth the trouble. Prejudice in favor of antiquity is too well anchored in the heads of certain archeologists to make it possible to ever give them too many proofs of the modernness of the American monuments.

If, from Kabah, we pass to Lorillard City, upon the left bank of the upper Usumacinta, we shall lack documents for assigning a precise date to the monuments; and yet we shall be able to consider them as equally modern, since the inhabitants must have been contemporaries of the Itzaes of Peten, who, we know, preserved their independence for more than 150 years after the conquest. Their capital, Tayasal, was not, in fact, destroyed until the year 1696, and it is very probable that our Lacandons, more distant and better fortified in their mountains, survived their cousins.

This supposition is confirmed by the historian Villa Gutierre Soto, who teaches us that the Itzaes of Peten were the enemies of the Lacandons; and he adds that in 1694, two years before the destruction of their city by the Spaniards, they were again making expeditions upon the Usumacinta, whose rapids they descended. But Boyle goes further, since he asserts that the Lacandons were still in full civilization scarcely 150 years ago, that is to say, in 1750!

At Lorillard City we find documents of the highest interest in the stone door lintels covered with bass-reliefs, some of which have a wonderful finish; as witness the one here reproduced (Fig. 2, opposite).

Aside from the heads with retreating foreheads, which, as we have said on the subject of Palenque and Yucatan, were not types of race, but only conventional ones modified according to the customs of certain classes, all is perfect in this bass-relief, and of a truly surprising richness of detail. Nothing in the primitive epochs of ancient civilizations offers us anything richer and better treated, and, for the country, it is a masterpiece. This document reproduces a religious scene, and we are present at a sacrifice.

One of the persons—the one kneeling—a priest, assuredly, has passed a cord through his tongue, and has provided it with spines, so that he cannot be tempted to remove it when once the cruel trial has begun. That would be impossible for him, and despite the pain that he must experience, it will be necessary for him, in order to crown the sacrifice, to cause the entire cord to pass through. The person standing is likewise a priest, who, holding a large palm-branch, lays it upon the tortured one in order to encourage him in his frightful undertaking.

Well! we are present here at a Toltec ceremony. In fact, the worship of Quetzalcoatl, left by the civilizer over the high plateaux, was carried by him, under the name of worship of Cuculcan, into the country of the Mayas. Torquemada, Sahagun, and Clavigero tell us of the torments that the priests of this Toltec divinity were obliged to inflict upon themselves.

"The priests of Quetzalcoatl, at Cholula," says Torquemada, "met together under the presidency of the oldest one of them, called *Achcautli*, and, after a fast of five days united with various penances, were shut up in the temple, to which they had brought along with them a quantity of sticks as long as the arm and as thick as the wrist. Then came some carpenters, who worked these sticks into suitable form. After this arrived the master workmen charged with the manufacture of the obsidian knives designed for opening the tongues. Then followed prayers; and the old and young priests being united and ready for the sacrifice, the most skillful of the master workmen opened the tongues of them here and there by making large holes therein.

"The principal Achcautli on this day at once passed through his tongue more than four or five hundred of the sticks that the carpenters had shaped; the other old priests did the same, and those of the greatest courage among the young ones imitated them. But the pain was so great that several could not reach such a number, for, although the first sticks were somewhat slender, the second ones were larger, the third still larger, and others as thick as the thumb, and a few more than double that, etc.

"In this time of fasting, the principal Achcautli visited the cities and villages in order to exhort people to penitence, and, as a signal, *he carried a green branch in his hand.*"

Here is our man with his great branch, and we are indeed present at a sacrifice in honor of Quetzalcoatl, Cuculcan.—*Désiré Charnay, in La Nature.*

NATURAL HEIRSHIP; OR, ALL THE WORLD AKIN.

By Rev. Henry Kendall.

The number of a man's ancestors doubles in every generation as his descent is traced upward. In the first generation he reckons only two ancestors, his father and mother. In the second generation the two are converted into four, since he had two grandfathers and two grandmothers. But each of these four had two parents, and thus in the third generation there are found to be eight ancestors—that is, eight great grandparents. In the fourth generation the number of ancestors is sixteen; in the fifth, thirty-two; in the sixth, sixty-four; in the seventh, 128. In the tenth it has risen to 1,024; in the twentieth it becomes 1,048,576; in the thirtieth no fewer than 1,073,741,834. To ascend no higher than the twenty-fourth generation we reach the sum of 16,777,216, which is a great deal more than all the inhabitants of Great Britain when that generation was in existence. For, if we reckon a generation at thirty-three years, twenty-four of such will carry us back 792 years, or to A. D. 1093, when William the Conqueror had been sleeping in his grave at Caen only six years, and his son William II., surnamed Rufus, was reigning over the land. At that time the total number of the inhabitants of England could have been little more than two millions, the amount at which it is estimated during the reign of the Conqueror. It was only one-eighth of a nineteenth-century man's ancestors if the normal ratio of progression, as just shown by a simple process of arithmetic, had received no check, and if it had not been bounded by the limits of the population of the country. Since the result of the law of progression, had there been room for its expansion, would have been eight times the actual population, by so much the more is it certain that the lines of every Englishman's ancestry run up to every man and every woman in the reign of William I., from the king and queen downward, who left descendants in the island, and whose progeny has not died out there.

It is a delusion to suppose that one man living seven or eight hundred years ago was one's ancestor to the exclusion of all the rest of the people living at that time in the country, and still having descendants in it. We have sprung from the whole mass; they were all our direct ancestors; we are vitally related to them all, directly descended from them all. Heraldry follows only one line of succession, the line of the eldest surviving son, the line that carries name and title and landed property. It is commonly imagined that one standing in this line of succession is more truly a descendant than other descendants. It is supposed that the eldest sons all the way are more truly descendants than the progeny of younger sons, or the posterity of daughters who have lost the very name. But each line of descent, whether by younger sons or by daughters, is just as real and as close as the one termed lineal agnatic. Every ancestor living 700 years ago has contributed as truly to the vitality of a present representative as the one whose name he bears, and whose peculiarly direct descendant he is considered to be.

It is morally certain, then, that all Englishmen of this generation are descendants of William the Conqueror and of Alfred the Great, and all the nobles of their times whose posterity have not died out. When we read in history of a brave deed done by an Englishman seven centuries since or more, we may say with confidence it was done by one of our fore-elders. And when we read of one at that distant period who was a dishonor to his country, we may say with certainty he also was one of our ancestors. All the lords, princes, and sovereigns, all the wise and good, the moral and intellectual aristocracy, were our forefathers, and we are their children by direct descent. Equally all the toiling myriads, without distinction of any kind, all the beggars and vagabonds, all the villains and scoundrels, were our forefathers, whoever we may boast ourselves to be, if, indeed, they have left descendants in the land. We are of them, and their blood circulates in our veins.

If the fact of our equal descent from so many ancestors be doubted, let the matter be tested arithmetically within the circle of two or three generations. The grandmother on the mother's side was equally my ancestor with the grandfather on the father's side. She was one of four ancestors that I had in the second generation, and owns a full quarter of me. The great-grandmother on the mother's side is equally an ancestor with the great-grandfather on the father's side. She was one of eight ancestors that I had in the third generation, and claims a full eighth of me. Similarly all standing on the successive steps of genealogical descent, and whose number is seen to be doubled at every step as we rise from the lowest upward, stand on the same level, and have equal claim to ownership in those coming after them.

Some deduction has doubtless to be made from the above rule on account of the recurrence, to a certain extent, of the same lines of descent. Thus if the father and mother are cousins, their children have only six great-grandparents instead of eight. If the grandfather on the father's side and the grandfather on the mother's side were brothers, their lines run up into one house, and not two separate houses, according to the common rule. Many lines must thus blend in the course of ages, and the multiplication of distinct ancestors be thus somewhat retarded. But, notwithstanding this deduction, it would require a miracle to prevent the interfusion of the blood of a whole nation within a brief period.

When we have gone back far enough for all the inhabitants of our country to have become related to us as fore-elders, they will be found, as we still travel backward, to go on for the most part intermarrying within the lines of consanguinity as drawn backward from us. The great majority of the marriages will be, of course, between men and women of the same country and the same race, who, by the operation of the law now expounded, have all been ascertained to be our ancestors. The boundaries of a country, especially in an island like ours, resemble the shores of a lake from which there is no outlet, and where the currents must circulate round and round the same basin.

Yet, as the self-contained lake does somehow manage to communicate with the great world of waters outside, as, for instance, by rain and by evaporation, so the multiplication of distinct ancestors, while retarded by nationality, is not arrested. Genealogy has curious means of planting new centers in other lands, and commencing there over again the same rapid ratio of multiplication, till successive nationalities are brought into intimate relationship. Let an ancestor be brought into the English succession from another country, and, since he can be shown to be in the course of a few generations related to all the people of that country, forthwith by his marriage here the whole nation to which he belongs is brought into our succession. One Frenchman embodies in himself, in miniature, all the French people of past times; one negro represents all the race from which he has sprung. Ancestral germs have thus been conveyed across the sea by emigration from France, from Germany, from India, and from the remotest regions to these shores, and by these means all the people of the earth will be found at no very distant period to have been brought into close kinship with us. The Norman conquest brought in all at once a large foreign element, expediting immensely our union with the people of whom they were part. The Danish invasions did the same at an earlier age; the expatriation of the Huguenots the same much later. All the world are found akin, not by going so far back as Adam, or even Noah, but within historical times.

It is often said, respecting a distant relative, "he is a thirty-second cousin." The truth is, perhaps, that he is a second or third cousin. As to thirty-second cousinship, it is startling to find that the whole human race comes within this line of consanguinity. By the ordinary unimpeded ratio at which ancestors multiply, they would amount in the thirty-second generation to 4,294,767,296; and reckoning for all the checks to this ratio through the blending of lines of ancestry, they must be reasonably estimated at the entire population of the globe, as high, in fact, as they can possibly go. The Caffre and the Hottentot, the Japanese and the Chinese, are doubtless all of them the reader's thirty-second cousins, or nearer.

There is a tendency from many causes for ancestry to diverge and spread itself over an ever-widening area; there is a struggle of the lines to part until universality has been reached, and every human being has come into the succession. Even where a tribal or religious custom mostly confines the marriages of the men in a community to the women of the same community, there are sure to be many exceptions." Jews sometimes marry Gentiles, and set the barrier that interposed between them at defiance. Boaz married Ruth, and she brought into Judah blood mingled of all Moab. When the Quakers made it a rigorous rule that members of the society should marry only with members, gates were hung in the hedge, and the fence itself was often broken through. Proselytes were brought in from the outside; members married non-members at the cost of excommunication. The law itself had eventually to be abrogated.

The tendency to avoid kinship in marriage has helped to increase the divergence of ancestral lines. While a large proportion of the marriages consummated are between persons living in the same district, the population of the district itself is continually undergoing modification, one stream flowing in, another flowing out. No use has been made in this argument of the existence of illegitimacy, and the boundless license of many periods of our national history. Yet doubtless moral transgression has greatly widened the area of relationship, and mingled in an indistinguishable mass the offspring of the rich and poor.

Hitherto we have been looking backward at the historical multiplication of the ancestors of persons now living. If we reverse the process, and apply the law of multiplication to the future, the result is equally startling. The average number of children may be reckoned on a moderate computation at two for every household. According to this average, a man who leaves permanent posterity behind him has the number of his descendants doubled every generation. The two children are followed by four grandchildren; the four grandchildren by eight great-grandchildren. At the twenty-sixth generation the number has swelled to 67,006,624. A few more generations would render them equal to the total number of the inhabitants of the globe. So that, if one could rise from the grave at a period no further removed from us in the future than the Conquest in the past, every person he met in the land, man, woman, or child, if not a mere visitor or recent immigrant, would be one of his descendants. Every one of them would inherit something of his nature. All would be his posterity, one as direct as another. The honorable and the base, the rich and the poor, the talented and the imbecile, would alike belong to his family, now swelled to gigantic proportions through the multiplying power of time. Broadly speaking, all the inhabitants of this country about eight hundred years ago were our fathers and mothers; all the inhabitants of this country about eight hundred years hence will be our children.

The low rate of multiplication just given is often seen to be greatly exceeded. The number of grandchildren and of great-grandchildren which some individuals leave behind them at death makes it easy to believe that in a few centuries an entire nation will be their veritable sons and daughters. While I have been writing this paper, an old woman has died very near to my residence at the age of ninety-nine, who had thirteen children and one hundred and two grandchildren and great-grandchildren, the latter, so far as known, all living. During the same time that the paper has been in progress, a Spanish gentleman, who went out many years ago to America, has returned to his own country, bringing back with him no fewer than one hundred and ninety-seven actual descendants.

A single plant, if unresisted by rival plants and unchecked by such things as climate and situation, would speedily cover the whole earth. Man has really no rival, he is lord of all; he can live, too, in every clime, and obtain a livelihood amid tropical forests and amid eternal snows. The rapidity with which the multiplication of descendants must go forward, even according to the ordinary rate of progression, will in the course of not many generations make the whole world our children, much more if it be expedited. Successive countries will be captured by various avenues and held in perpetual possession by our posterity. The whole caldron of humanity, seething evermore with new creations, will acknowledge the presence of every individual progenitor of this period.

The race is incalculably more than the individual. The peculiarities of the individual are soon melted

away in the general stream of humanity. As if his brief sway in the little circle he has filled were viewed with envy or dissatisfaction, the hand of Time begins immediately to pare down what remains of him in the earth to ever smaller dimensions, until it is infinitesimal. He can insure only half of himself in any individual of the next generation, only a quarter in the generation after that, and so on. His part in the building up of any human fabric rapidly becomes insignificant. Something seems bent on working him out. As it does with his name and memorials, filling up the lettering on his tombstone with moss, destroying the writing he has left behind, wiping out all traces of him from the earth, so it does with himself and all that vitally represents his personality in the persons of his descendants. The individual is ever losing; the race is ever gaining. A man's great-great-great-grandchild, living scarcely two hundred years after him, will be only one thirty-second part of himself, and the other thirty-one parts will be due to others, that is, to the race viewed as something opposed to his individuality.

The gain in the way of extension compensates for the loss of intension. While a man's part in the individuals descending from him rapidly becomes infinitesimal, the number of individuals in whom he has part rapidly increases until it includes, as we have seen, all the nation and then all the world. This widening out of his personality corresponds to the broadening of intelligence from mere interest in local news to that which is taken in scientific generalizations, and to the tendency of moral development, which is to expand the love of family into patriotism, and then to convert patriotism into philanthropy, into a regard for man as man, irrespective of language or nationality. Thus the brook seeks the river, the river the sea, the sea the vast ocean.

Each man's personality, it has to be remembered, is borrowed from those behind him. The further back in time a man's place may be, the fewer ancestors he has behind him; the greater, too, his own part in the race, viewed as a whole existent through the ages, the oftener the infinitesimal resowing of him takes place, and the greater becomes the certainty that every separate inhabitant of the earth is one of his descendants. Furthermore, when there are fewer people, the lines of ancestry blend oftener, so that in the same individual it is more probable that an ancestor will be represented many times by means of different channels of descent meeting in him after proceeding from the same source. Posterity, not very remote, will have descended from a common ancestor through several of his children. A progenitor's part who lived three thousand years ago is very much larger than that of one who lived only one hundred or three hundred years ago. He has had more to do in the shaping and moulding of the whole, just as the stem has more to do in the formation of the tree than any particular branch proceeding from it. The root or the seed has needed. Even self-love comes to the aid of generosity; it is felt that what a man does for his own relations is in a measure done for himself; the disgrace of neglecting them acts as a useful spur to liberality. Advocates of slavery have vindicated their obnoxious system by maintaining the absolute inferiority of the enslaved. Caste in India has been fortified by notions of a vast and essential difference between the various orders. Oneness in nature appeals for respect and association. The oneness which is proved and emphasized by near relationship makes the strongest appeal to the interest of the mind and the sympathy of the heart. Creatures of the same kind draw together. The further a people are from us, geographically or relatively, the less ordinarily is our regard for their welfare, our concern over their calamities. The improved facilities for intercourse are destroying the effect of geographical distance; the realization of the fact that all the world are near akin will help immensely to lessen the social distance.

The close kinship of mankind, especially in the same nation, has an important bearing on one or two points of theology. Since mental and physical tendencies are got rid of, defects are supplemented, excesses are restrained; a certain amount of refuse is wrought out and cast aside age after age. The blind man has children with eyes. On the whole, we cannot marvel that with such a mongrel ancestry of saints and sinners we manifest such contradictory tendencies, and are such an enigma to ourselves, as if not two men but a thousand were contending within us for the dominion in the changing moods that pass over us, and in the wild, irregular thoughts that shoot through the mind, and try to find their way to the surface to gain their own appropriate expression. That blessing and cursing should proceed from the same lips, that men should come away from prayers at church and get into very unlovely tempers at home, is doubtless very sad, but it is just what might have been expected from those who reckon among their progenitors the evil and the good, the best and the worst of a whole country.

This doctrine of the close kinship of mankind triumphantly establishes, apart from genealogical tables, the fact that Jesus Christ had descendants from King David, but impairs the value of the fact when it is established. David, the King of Israel, flourished above

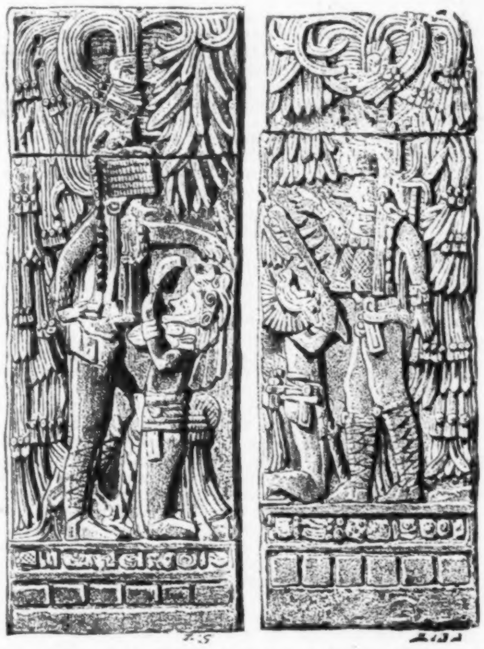


FIG. 1.—BASS-RELIEFS FROM KABAH, YUCATAN.

FIG. 2.—STONE LINTEL FROM LORILLARD CITY, YUCATAN.

a still greater part, and, if it be conceded that the human race has proceeded from one common pair, it follows that of the nature of all the individuals now living half is of the proto-father and half of the first mother. To us existing at this late date, it is interesting to note how the channels of vitality, proceeding from the original pair to us, first diverge until they reach their numerical climax, and are coincident for a considerable period with all the inhabitants of the world; then converge until they are found reduced to two again in the household from which we immediately sprang.

As the people at no very distant date in the past were all our fathers and mothers, and the people who will be living not very far distant in the future will be all our sons and daughters, so the people living at the present time are all our near relations. We may call them, with very little exaggeration, brothers and sisters. If we could be told, as we meet the passers in the streets, how near their relationship to us is, we should get a succession of surprises. We should cease to think of them as strangers and aliens, and come to feel that they were our own kith and kin. Every person would have an interest for us as a relative not far removed, and the charm of social life would be wonderfully increased.

The fact of our close kinship, as a nation, and also as a race, is calculated to stimulate philanthropy very powerfully. It is acknowledged that the nearer the relationship the greater is the claim for help, if help be transmissible by hereditary descent, this kinship gives to the doctrine of natural depravity an awful significance, and shows the causes of taint to our blood to be near us in time instead of being removed altogether away to the beginning of the world. If all the moral weaklings of the land who lived seven hundred years ago, all the vile and vicious, all the wild beasts in human shape, and an unknown number of such in the ages intervening, were our direct ancestors, it is not to be wondered at that unhappy propensities stir, and strive, and struggle for mastery in every man's breast. It is singular that orthodox theologians should overlook this recent pressing source of depravity to dwell on the influence upon us of an original pair living before historical times. It is equally strange that unorthodox ones should deny the existence of depravity communicated from that remote period on the ground of its supposed injustice, when it is undeniable that we are reached by ten thousand impure channels so near at hand. The question arises, How is it that the depravity fed from so many sources has not resulted before now in the complete corruption and disintegration of the race? We are able to encourage ourselves by remembering the vast amount of excellency in recent times with which we are in direct communication; the heroes, saints, and martyrs, to say nothing of the hosts of good, plain, practical people of all sorts who have left us a constitutional heritage. We have further encouragement in the law by which successive generations tend to revert to a normal type; peculiarities are a thousand years before Christ, and left behind him many children. The channels of succession being so numerous, and having their fountain-head so far back, had time before the birth of Christ to branch out in every direction, and could not have missed any genuine Jew in the land, especially if he was of the tribe of Judah. Jesus Christ, being of this tribe, was undoubtedly in the succession, and had in him the blood of the son of Jesse. But then was there a man of the tribe of Judah at least who had not? Is there a man living now who has not? Of course the conventional value of Christ's descent by what is termed lineal succession from David, and its value as a fulfillment of prophecy on that ground, are independent of the generalizing proofs which would make out all to be David's children.

The evidence seems conclusive that Mary, the mother of Jesus, had several children after the birth of her illustrious First-born. He had brethren and sisters, and if some of these left posterity in the earth, as we may reasonably suppose they did, it is certain that we are the descendants, the children, of Mary, and have a kinship with Christ, much closer physically than we have dared to believe.

In his case the phrase "Son of man" had a unique significance, but the doctrine which has been expounded in this paper shows that it has a real and solemn significance to whomsoever applied. Each of us is "son of man" in the tremendous sense that he is descended from all the people who have posterity re-

maining, who lived on earth a few centuries ago. Every individual living before Christ who has descendants at all has them in us. We are the offspring of the whole of humanity at that time. Every slave and every lord in the days of Julius Cæsar has contributed to our being, and, looking back to those times, each one may consider himself not the child of a thin, thread-like line of parentage, but child of the race, son of all mankind.

This subject has important bearings in the political realm. It invalidates the basis of hereditary monarchy, and shows that it rests upon a genealogical fiction. It is a depraved conventionalism, a custom born of falsehood and of wrong, to single out the eldest child or any other child as the bearer of the honors and emoluments of the family to the exclusion of the rest. All the children are equally partakers of the parental nature. In the course of less than a thousand years the descendants of an illustrious sovereign get strangely dispersed, and his blood becomes mingled with the common reservoir of national life. Every marriage outside his family runs off with half of what remained of him in the succession. After being halved so often, the wearer of his name and title, the possessor of his power, needs much faith or much ignorance to believe that he is in any real sense the peculiar descendant, having a claim in nature beyond millions more. If the sovereign is the descendant of William the Conqueror or of Alfred the Great, so are the subjects. On the ground of hereditary succession, every man may claim to be king, and every woman to be queen.

Hereditary aristocratic titles have no foundation in nature. They are based upon deception and injustice, and at best are purely arbitrary. The eldest son who takes the title is no more the child than the rest of the children. If any title is inherited, it ought to be common to them all, and, if the titular inheritance continued, it would be common to all the population of the land in the course of a few ages. It is restricted to one channel of descent under the delusion that this is more direct and is somehow closer to the founder of the family than other channels. The restriction takes place by means of a wrong done to the rest in excluding them from that which is as much theirs by right of nature as his who actually enjoys it. There could be no hereditary aristocracy save by the ignorance and weakness of the community at large, who tolerate the presence of a few among them flaunting in their eyes and jingling on their ears the tokens of the general deprivation of a natural due.

The doctrine of the close kinship of the nation practically carried out would lead to a universal distribution of property. The verdict of society is that a man who has property should leave it to his children after making due provision for his wife for the remainder of her days. This is the general rule which the common judgment of mankind prescribes, leaving only a small margin for bequests outside the family circle. Entail in its present form and primogeniture are doomed to go, and only wait the hour and the man. Law has already relaxed the grasp of the eldest son on *personal* estate, and provides for its distribution. In France it compels an equal distribution of *real* estate among all the children. Taking, then, the broad rule for granted that the possessions of the parents must pass in equal portions to the children, there is seen to be wanted some strict guard on what a man bequeaths, so that it shall not be squandered by his heirs. We can best follow out the result in regard to possession in land. Entail should be placed on a natural basis and carried out on a broader scale, and it would become a mighty instrument for good and for raising the general condition of the people without taking away the stimulus to labor.

There is provision in nature for the nationalization of the land. As soon as all the direct descendants are treated as heirs, the fact that these rapidly multiply till they are coextensive with the nation shows that, if the property left at death by the present possessors be similarly extended, all the land of the country now in so few hands must eventually come into the possession of the whole nation, and that not by any act of confiscation, but by simply acknowledging fact and doing justice. It would not answer, however, to go on subdividing property endlessly down to yards and inches. A limit would have to be set to subdivision and to inheritance by means of it, and after a certain generation, where the descendants had already become scores of hundreds, or after a certain degree of tenuity in the property had been reached, so that the forfeiture of his share would be no particular loss to the individual heir, it would be necessary to annex the whole to the national estate, swiftly accumulating by similar processes. If this rule were universally acted upon, though a man's descendants would cease, say, in the fourth or fifth generation to be his heirs in particular, the little amount they forfeited in this way would be more than made up to them by the many other inheritances of which they would become heirs in common with the nation. The railways could be passed through the same process by the gradual distribution of shares. As far as practicable, other property should be dealt with on the same principle. This would bring about a general diffusion of wealth now congested in a few hands, and bring it about, too, gradually and safely by the operation of the great natural law of heirship through successive generations.

Already we have extensive properties that are owned by the nation at large, such as the roads and canals, the post-offices and telegraphs, the board-schools and the established churches, the parks, free libraries, and government buildings. The principle is in operation, and, if it had the wider sphere that heirship demands, there would be an immense lightening of the burdens which are pressing upon the people. Each individual would commence life at an advantage, a few steps up the ladder instead of being down quite in the ditch, as are the majority—poor and penniless, dependent for everything on the exertions of the present hour. The rent of the national property might, as has been recently advocated, go to the payment of the taxes, imperial and local. It might answer for the necessary work of government, for the expenses of army and navy, for the payment of interest on the national debt, and its gradual liquidation, for the elementary education of the children, and for the maintenance of the aged. Though I have not read Mr. George's book, I understand that this is something like his proposal. If the yearly return of the national estate were ever found to far exceed the above requirements, it could be readily and safely disposed of by a yearly dividend, which would reverse the old tormenting order, and make the people the receivers instead of payers of taxes. It is hard to see how this moderate diffusion of property could be injurious to them. If the smaller equal inheritance would degrade them, the present holders of large estates must be in a very bad way.

That which a man has accumulated by his own exertions he has a sort of right to disperse and to squander if he choose; but that which the dead have left behind them should, as far as possible, have permanence stamped upon it, and be guarded by the state, so that it may be enjoyed by all the heirs in their turn. The savings of the present generation should enable the whole community in the next age to start from a higher level of power and comfort. The law of labor can never be abrogated, though its incidence might be very wisely extended. The inequality between the possessions of men can never be totally destroyed, but with immense advantage to the nation it might be decidedly lessened. The progress that has thus far taken place in the condition of the people has been the laying of succesive strata of comforts and resources between them and the utter poverty in which their forefathers dwelt. The increase of wages, the lessening of the hours of labor, the manifold fruits of modern inventions, the accumulated treasures of knowledge which all may take without diminishing the store—such instances as these show a gradual enrichment of the people to the general advantage. Who shall say that the process has gone as far as it ought to go? What harm could ensue if the present burdens of taxation were done away, and if even every man were the recipient of a yearly income of a few pounds which no act of his could ever alienate?

The landless people of the present generation are undoubtedly proportionate heirs to all the landowners of the country living not many ages ago, if heirship be founded in nature. That all should have gone into so few hands, and the vast majority of the heirs have been deprived, is a great and grievous wrong. Those who wish to continue the present arrangements, and would bitterly oppose their modification in the way here proposed as an injustice to the few who in future would otherwise come into possession, are willing to inflict injustice upon the many of the future who ought to come into possession.

The great possessions now enjoyed by particular individuals, and that have come down from distant times, are due to accumulated wrongs. One heir in the succession has been advantaged to the exclusion of scores, and eventually of thousands and millions. That which in nature was as much theirs as his is now his alone. That which should have flowed in many channels, shallow, but sufficient to fertilize, has been carried in a single stream, deep and full, but comparatively useless—mostly wasted. Much of the waste is seen clearly and painfully enough in the profuse and extravagant style of living, where one consumes what would decently maintain a thousand. When the properties of the country are thus piled up on a foundation of gigantic wrong, it would be unreasonable to expect a full measure of national health and prosperity, or that it should be really well with the people.—*Nineteenth Century.*

METEORITES.

ON December 29 last, Professor Dewar began a series of lectures at the Royal Institution on "The Story of a Meteorite." He stated that records of the fall of meteorites extended to high antiquity, biblical, Grecian, and Latin writers having noted their occurrence. He had been at some pains to get together a good variety of meteorites to exhibit to his hearers, for the objects being so rare, scientific men and others are exceedingly desirous to possess specimens, consequently any meteorites that fall are quickly bought up, and in most cases find their way into private collections. Professor Herschel, who had done much in this field of inquiry, had lent him specimens; so also had Professor Geikie. Mr. J. R. Gregory had lent him specimens from his collection, casts from those in the British Museum were on view, and one of the rarest gems before them had been lent by Mr. Warren de la Rue. It differed from all the others, and was so friable that it had to be kept under a glass case. Specimens of meteorites had also been lent by Professor Abel, Dr. Sorby, and Professor Bonny. The advent of a meteorite in daylight, he said, is sometimes accompanied by a cloud, and by a noise louder than thunder, followed by a sound like that of wild ducks rising from the water. Then comes a hole in the ground. The pieces on being immediately dug out are usually hot, but sometimes cold. In 1860 the fall of a meteorite was witnessed by many Europeans and others in India, and a report of the occurrence was drawn up and sent to the Governor of the Punjaub; the remarkable fact about this meteor was that, although at first it was warm, it quickly grew so cold that the holders had to drop it, because their fingers could not bear the low temperature. Meteorites are covered with a varnish-like glaze about as thick as writing paper, in which glaze are fused globules, proving the action of heat. Most meteorites are under 1 lb. in weight; indeed, a meteorite of 1 lb. weight is a comparatively large one, although in some few cases the weight of meteorites has been known to reach 3 or 4 tons. They can be divided into two great types—namely, the metallic type, rich in iron, and the stony type; there are also intermediate specimens, partly stony and partly metallic. All that can be observed in relation to their fall takes place in a very few seconds, their velocity being like that of what are popularly called "falling stars;" they move, in fact, at planetary velocities. Some idea of their speed can be gained from the following tables:

Velocities.

Shot from 100-ton gun.......	$\frac{1}{6}$	mile per sec.
Explosive wave, gaseous.....	$1\frac{1}{13}$	" "
Gun-cotton..................	$2\frac{6}{13}$	" "
Earth in orbit..............	18	" "
Meteorites..................	36	" "
Comets......................	45	" "

Relative Velocities.

Falling body.........	32	feet per sec.
Racehorse............	50	" "
Flight of pigeon......	60	" "
Fast train...........	90	" "
Contraction of soap film................	96	feet per sec.
Impression along nerves...............	97	" "
Ignition of gases......	100	" "
Sound	1,100	" "
Air particles..........	1,500	" "
Cannon ball...........	1,700	" "
Gun-cotton............	15,000	" "
Earth in orbit.........	95,000	" "
Light.................	1,100,000,000	" "

Meteorites have not all the same velocity; some exceed 36 miles per second. A meteorite traveling at 50 miles per second may be visible for about nine seconds, its total path in that time being 450 miles, or about the distance from London to Edinburgh. The path of one which passed over the British Isles was discovered to be about 70 miles above the surface of the earth.

Bodies, said Professor Dewar, which move at high velocities acquire great rigidity. In illustration of this, he hung an endless chain upon a wheel, and caused the chain to travel round the wheel at the rate of half a mile a minute, by driving the wheel with an electromotor and dynamo machine. He pointed out that the chain had then the rigidity of a thick wire, and that if struck with a stick the loop would curve into forms which it would retain with some persistency, as if it were a continous wire rather than a string of loose links. He next took a disk of common thin sheet India-rubber, and attached the center of it to the electric engine shaft; when the latter was rotated rapidly, the sheet of India-rubber spread itself out until it had acquired a kind of "screw" form; it did not extend itself quite flat. At this velocity it had high rigidity, gave a roaring noise, and cut a sheet of paper near it into shreds. This roaring noise, he said, was related to the noise made by meteorites. To produce such a noise it is not necessary that a solid body should rupture the air; a series of induction sparks from an intervening electrical condenser ruptures the air, and produces a very disagreeable noise.

Once upon a time it was believed that meteorites were due to inflammable gases rising in the air, until after a time they caught fire and produced "fire balls;" but later on other ideas came under consideration, including that of friction. The speaker here attached a smooth iron wheel to his electrical engine, and showed that at a high velocity of rotation it would cut red hot iron as, he said, rails are cut at iron works. He next used an emery wheel at high speed, and produced showers of sparks by pressing a piece of iron against it, the effects, he said, being remarkably like those produced by the fall of meteorites. He exhibited on the screen a magnified image of an instantaneous photograph of the shower of iron sparks, and pointed out how some of the iron particles were brighter at some parts of their path than at others. Some of the particles appeared also as if on the point of bursting. He collected some of these hot iron particles upon a glass plate, into the surface of which they fused themselves. Afterward he dissolved out the particles with acid, and showed that they left little round holes in the glass, and that the particles themselves were round. The heat of the particles, he said, was partly due to friction and partly to combustion in the air. He also collected some of the sparks upon a glass plate with a horseshoe magnet behind it. The shape of the poles was visible where they burnt themselves into the glass, also some of the lines of magnetic force, as they have been called.

THE HEAT AND LIGHT OF METEORITES.

At Professor Dewar's second lecture, he attached a thermo-electric couple, consisting of a slip of iron and a slip of copper, to the electrical engine; one slip was attached to the rotating shaft, and the other had rubbing contact with a fixed axis of the shaft; the thermal couple was fixed at right angles to the rotating shaft, and its head being outward, rose in temperature as the pressure of the air before it increased with increased rapidity of rotation. The variations in temperature were read off by means of a reflecting galvanometer. In relation to the rigidity of soft substances at high velocities, he spoke of the rural pastime of firing a tallow candle from a gun through a door, and he illustrated it by firing some balls of paraffine wax, which, he said, were cleaner than tallow balls, through a deal board. He collected the pellets afterward from a sandbag at the back of the board; they had made clean-cut round holes in the wood. He also cut a plate of iron with a rapidly rotating disk of lead. Some lead, in a state of excessively fine division, was allowed to fall from the roof of the theater, whence it descended in fiery streams, to illustrate heat from combustion in passing through the air, more than heat from friction. A piece of glass was made white-hot, and partly fused, against the rotating emery wheel, as an example of heat from friction without combustion. That the sparks from iron were partly due to combustion he proved by covering the emery wheel with a glass case, filled with carbonic anhydride, when upon application of the iron, not a spark was to be seen; a red glimmer was visible at the point of friction; with pure oxygen a brilliant shower of sparks was seen under otherwise like circumstances. The iron sparks in air, he pointed out, were so hot that he could light a gas jet with them at a distance of 2 ft. or 3 ft. from the wheel. He collected some of the particles on paper at that distance, and proved that many of them were small enough to float upon water; they varied in fact from $\frac{10}{1000}$ in. to $\frac{1}{1000}$ in. in diameter. He had, he said, the Newstead iron and nickel meteorite, belonging to himself, so he could do what he liked with it; he accordingly placed its edge against the rotating emery wheel, and but a dull red heat was produced, with a lesser amount of sparks than iron or steel would have given under like circumstances. He then put a piece of pure nickel against the revolving wheel, and it gave out less heat and light even than the meteorite, although nickel so resembles iron in some of its properties. Sir F. Abel had given him permission to do what he pleased with a polished plate from a large metallic meteorite. He accordingly etched it with weak acid, to show that some parts of its surface were more soluble than others, and that evidences of crystalline internal structure were thus brought to view. He exhibited upon the screen magnified images of the etched surfaces of meteorites. In relation to the traveling of flame, he said that flame might travel with great velocity without direct change of place of the substance burnt, as in the immense velocity with which the flame of ignited gun-cotton moved.

He also, by experiment, proved that in a mixture of gas and air in a long thin tube, flame travels with a series of successive short jerks, and that the opening or the closing of the further end of the tube modifies those jerks.

THE COMPOSITION OF METEORITES.

At his third lecture Professor Dewar drew attention to the following tables of figures as to the composition of meteorites:

Meteoric Stones.

	Silica.	Magnesia.	Iron protoxide.
Alais	31·22	22·21	29·03
Kold-Bokeveldt	30·80	22·20	29·94
Kaba	34·24	22·39	26·20
Orgreil	26·08	17·00	29·60
Chassigny	35·30	31·76	26·70
Chateau Renard	38·13	17·67	29·44
Harrison City	47·30	24·53	28·03
Concord	47·30	24·53	28·03
Danville	50·08	20·14	19·85
Searsmont	40·61	36·34	19·21

Meteoric Irons.

Iron	85·54
Nickel	8·55
Cobalt	0·61
Copper	0·03
Magnesia	2·04
Chromic oxide	0·21
Silica	3·02
Phosphorus	0·12

Alpianello Meteorite (proximate components).

		Per cent.
Troilite (iron sulphide)	6·92	
Nickel iron	2·11	Nickel 71·2; Iron 28·8
Soluble silicate	50·86	
Insoluble silicate	40·11	

	Soluble silicate.	Insoluble silicate.
Silicic acid	35·12	12·56
Iron protoxide	51·43	13·40
Alumina	1·52	—
Chromium oxide	—	8·28
Lime	4·64	6·71
Magnesia	7·27	17·26

Professor Dewar exhibited magnified representations of Mr. Storey Maskelyne's thin sections, of real meteorites, also photographs of sections, showing that stony meteorites consist generally of confused crystalline masses interspersed with jagged pieces of metallic iron, and that the iron sometimes runs between the other crystals in veins. He announced that Mr. J. R. Gregory, who possessed the Indian meteorite of which he had spoken in an earlier lecture, had broken up some of it in order to give a small piece to the younger members of the auditory present at those Christmas lectures. On examining meteorites, he said, the resemblance they bore to the varieties of lava emitted by volcanoes was evident; there were also differences in the matter of the large proportion of magnesia and metallic iron in meteorites. Olivine and the basalts present the same form of irregular internal crystallization, but without the iron. Another difference is the thin varnish like coating of meteorites; this cannot be produced artificially by throwing a piece of meteorite for a moment into the electric furnace, because the heat is neither sudden enough nor hot enough. He proved this by experiment, and the glaze went far too deep, whereas in meteorites it is but of about the thickness of writing paper. On taking the piece of meteorite out of the furnace, he remarked that burning gases were coming from it, a phenomenon that he had never seen before, and that there was a little crater on the fragment of meteorite whence the gases issued. A heat of about 3,000 deg. would account for the thin varnish-like crust of meteorites. Iron, nickel, silicon, and oxygen are the more common of the constituents of meteorites; magnesium is somewhat plentiful in them; in all, twenty-two of the chemical elements have been found in them. Compounds of sulphur are always found in meteorites; such compounds yield most readily to acids when meteoric plates are etched, and a smell of sulphureted hydrogen is then given off. The particles of iron can be separated from a crushed meteorite by means of a magnet, and what is left is simply a glass, consisting of silicates like the masses of rock silicates common on this earth. The bases with which the silica is united are chiefly oxide of iron and oxide of magnesium, both in quantities not so relatively plentiful upon earth. He then spoke of the nickel-iron alloy of meteorites, and the general characters of alloys, illustrating his remark by the manufacture of aluminum bronze. He also spoke of phosphorus in meteorites, and the properties of phosphide of calcium. Next he pointed out that meteorites sometimes contained graphitic carbon; but no diamond had ever been found in them. If a diamond were to be so found, the temperature a meteorite had endured could be more exactly specified, because at a known temperature a diamond would be carbonized, and it would be possible to say that the temperature of the interior of the meteorite had not reached that of the electric crucible. He then explained to the listeners by experiment some of the properties of silica, and how it could be separated from the other constituents of meteorites by hydrofluoric acid. In reference to the Indian meteorite—which felt hot at first, but intensely cold afterward—he said that he would exhibit an inverse but otherwise perfectly parallel experiment. One of the assistants then poured masses of white-hot molten glass, as big as apples, into cold water, and the instant they fell therein Professor Dewar picked them out while still white-hot with his bare fingers, and placed them on an iron plate on the table. He said that he seized them at the instant they were surface-cool; if he were to retain hold more than about a second, of course he should be burnt; conversely, a meteorite might be at first hot outside, but soon grow too cold to be held in the hand. Some meteorites, he said, are partly glassy and partly not so, just as in metallic slags. As to the relation between velocity in air and temperature, a velocity of 145 ft. per second gives an increase of 10 deg. temperature, and the rate continues as the square of the velocity. The surface of a body moving at the rate of thirty-nine miles per second would reach a temperature of 2,000,000 deg. A thin layer of meteorite at an elevation of 100 miles would, in its passage, reach the temperature of 3,000 deg.

GASES IN METEORITES.

At the fourth of his lectures, Professor Dewar begun by speaking of the large proportion of magnesia in meteorites, and showing experiments to prove that earthy mixtures containing that substance have a tendency, after being moistened, to set rapidly into hard masses of the nature of solid stone. In the interior of meteorites stony crystals are heterogeneously cemented together, and he pointed out that a method of readily ascertaining, to some extent, the nature of these crystals is to take a thin transparent or translucent slice of meteorite and to examine it by polarized light; the crystals are then differentiated by the colors or markings they exhibit. The bottoms of two common glass tumblers, apparently just alike, and purchased at the same time, at the same shop, were placed in polarized light, and images of them projected on the screen; one then still appeared perfectly transparent, but the other had dark markings, due, the speaker explained, to the glass being under conditions of stress and strain, because of imperfect annealing. He showed that certain gems contain air-spaces, sometimes partly filled with liquid, sections of certain topazes presenting this phenomenon; the heat of the electric lamp in some cases volatilized the liquid within the spaces; the liquid, he said, was carbonic acid under pressure. The topaz, he stated, is silicate of alumina. In meteorites no such liquid is found, but air-spaces occur in the crystals, and these spaces appear to have been once filled. Meteorites contain gas, which is practically coal gas in another form, and it can be extracted from them by means of heat and the Sprengel pump; such gas is also ejected from volcanoes. The late Professor Graham, of the Royal Mint, was the first to extract gas from meteorites, and the fact was illustrated by the lecturer, who extracted some of the gas from a powdered fragment of the Indian meteorite. Some metals, he said, occlude and evolve gases with much facility; palladium, for instance, will absorb a considerable quantity of hydrogen, give it out again with heat in a mercurial vacuum, and absorb the gas once more as it cools. Silver, he said, absorbs oxygen at high temperatures, and the peculiarity of the phenomenon is, that silver absorbs the gas at temperatures which cause other metals to give it out. As the silver cools, the metal gives it out from little craters which form upon its surface; he illustrated this by experiment, and caused the gas issuing from the little craters to make the end of a smouldering taper burst into flame several times in succession.

Pumice, the lecturer stated, is merely volcanic glass or lava blown into froth, and large portions of stony meteorites consist virtually of glass.

Pumice floats on water, not because it is lighter than water, but because it is so full of bubbles, and in great volcanic eruptions the sea is sometimes covered for miles with pumice several yards thick, so that ships can hardly get through the floating masses. He caused some lumps of pumice to rise and sink alternately in water, by varying the pressure of the air above the surface of the water. On the sea the pieces rub against each other, until finally they sink, and cover much of the ocean bed with fine volcanic dust, which can be raised by dredging, and when fused it forms a dark kind of glass resembling common bottle glass. The most potent agent for ejecting materials from volcanic craters is high-temperature steam.

He called attention to the following table relating to the gases found in meteorites:

Gases of Meteorites.

	Iron Meteorites.		Stony Meteorites.	
	Texas.	Auguste.	Pultusk.	Parnallee.
Carbonic acid	8·59	9·75	60·29	81·02
Carbonic oxide	14·62	38·33	4·35	1·74
Hydrogen	76·79	35·83	29·50	13·59
Nitrogen	—	16·09	2·26	1·57
Marsh gas	—	—	3·61	2·08

THE TEMPERATURE OF AIR AT HIGH ALTITUDES, AND OF STELLAR SPACE.

In his fifth lecture Professor Dewar said that Captain Noble had sent him from Sir William Armstrong's works a large block of steel, in the center of which he had fired off some gunpowder, and imprisoned the resulting gases, without bursting the block; he would open the vessel after the lecture, and let out the gases then, rather than at the beginning of the discourse, because the gases had an unpleasant smell. The pressure of the gases, he said, was then not so powerful as directly after firing the gunpowder, because at that time they were greatly heated, but had since had time to cool down. It formed a large illustration of how gases might get into crystals formed at a low temperature. He also exhibited a block of malleable iron, originally about a foot square, but subsequently broken into four tolerably uniform rectangular pieces by the firing of nitro-glycerin which had been poured down a small hole in the center of the original block. He pointed out the crystalline structure of the ruptured iron.

The lecturer next spoke of the heat generated by the pressure of the air against a meteorite traversing the upper regions of the atmosphere, and called attention to the following table:

Effects of Pressure on Air.

Pressure in atmospheres.	Elevation of temperatures.	Pressure in atmospheres.	Lowering of temperatures.
2	95	1/2	71
4	221	1/4	125
8	389	1/8	166
16	612	1/16	196
32	911	1/32	219

He illustrated the heat generated by the compression of the air, by suddenly forcing down a plunger into a glass tube closed at the lower end; the quick compression of the air to one-sixth its former bulk caused a little flash of flame; he subsequently pointed out that the expansion of the air in the tube produced a cooling effect.

Professor Dewar then drew attention to the low temperatures of the higher regions of the atmosphere of the earth, also to the accompanying tables in relation thereto, and to the estimated temperature of space:

Temperature of Space.

Herschel	—150 deg.
Hopkins	— 38·5 "
Fourier	— 50 "
Pouillet	—142 "
Pictet	—274 "
Rankine	Nothing.

Barometric Pressure, Altitude, and Temperature.

Inches of mercury.	Altitude in miles.	Temperature.
30	0	+ 15 deg.
25	1	+ 7 "
20	2	− 1 "
17	3	− 9 "
14	4	− 17 "
11	5	− 25 "
4	10	− 65 "
2	15	—105 "
1	20	—145 "

No living person, said the lecturer, has ever yet reached a height of five miles above the surface of the earth; some day, he said, people will no doubt be able to rise ten miles above its surface, but not without protection from the cold, and carrying up their necessary supply of air. It is certain that in the region traversed by the meteors so often seen flashing through the air by night, the temperature must be exceedingly cold and the atmosphere exceptionally rare. By modern methods exceedingly low temperatures can be produced; the once low temperature of 100 deg. C. below the freezing point of water, or as many degrees below the freezing point as that of boiling water is above it, can now be greatly exceeded, and that of the expansion point of hydrogen, or —203 deg. C., has been reached. There is reason to suppose that 273 deg. C. below the freezing point of water is the absolute zero of temperature, although it is nothing as compared with the temperatures obtainable above the freezing point of water.

He then illustrated the cooling of water by evaporation, by means of Wollaston's "cold carrier," consisting of glass bulbs at opposite ends of a long horizontal tube, the one bulb containing air, and the other water. A freezing mixture was placed around the air bulb, which chilled and froze the vapor of water entering it along the tube, until at last the remaining water in the bulb at the other end of the tube was frozen by its own evaporation. He said that if one could be inside the tube while this was taking place, he would find himself exposed to a perfect hurricane. He then explained that by the evaporation of solid carbonic acid a far more intense cold can be produced, and a greater still by the evaporation of solid ethylene, the chief illuminating constituent of coal-gas. Some liquid nitrous oxide was poured into a glass bottle, and made a cracking noise against its sides because of the difference in temperature; the mouth of the bottle was connected with the air-pump for an instant, and by partial evaporation cold enough resulted to freeze the rest of the liquid into nitrous oxide snow, which, in appearance, resembled carbonic acid snow. The accompanying table gives the temperatures at which various liquefied gases boil:

Boiling Points below the Freezing Point of Water.

	Boiling point below freezing point of water. Deg. C.	Boiling point 5 to 10 mm. pressure. Deg. C.
Carbonic acid	— 80	—116
Nitrous oxide	— 90	—125
Ethylene	—103	—142
Oxygen	—184	—211
Nitrogen	—198·1	—225 solid.
Air	—192·2	—207 solid.
Carbonic acid	—193	—211
Nitric oxide	—153	—176
Marsh gas	—164	—201 solid.

The highest of ordinary clouds, he said, never reaches an altitude of more than five miles; at four and a half miles clouds cease to be liquid water, and at higher elevations must consist of particles of ice. The lower rain clouds are but one mile high.

Height of Clouds.

	Miles.
Cirrus	4½
Cirro-Cumulus	4
Alto-Cumulus	2½
False-Cirrus	2
Cumulus	1

Professor Dewar then exhibited some radiometers and vacuum tubes lent to him by Mr. William Crookes, remarking that solids in high vacua have great mobility, and that a very rare atmosphere favors electrical discharges, consequently at high elevations material conditions obtain with which we are not generally familiar in the lower regions of the atmosphere of the earth.

To show that low temperatures can be accurately measured, he said that he would prove that his thermometer was trustworthy. It consisted of a thermo-electric couple of copper and iron, connected with a reflecting galvanometer, and by the evaporation of solid carbonic acid he produced a temperature of about 100 deg. C. below freezing point. The lowest temperature ever obtained by Faraday was, he said, —115 deg. C. He pointed out how accurately the thermometer indicated the various temperatures; after which, by the use of ethylene, he liquefied common air. He also caused liquid air to evaporate by taking off the pressure in the tube. These phenomena were visible to all present by means of magnified images thrown upon the screen by the aid of the electric light.

A SIMPLE preparation for rendering woven fabrics more or less incombustible consists of three parts of borax and two and a half of sulphate of magnesia, mixed with twenty parts of water just before using. The fabrics are first thoroughly impregnated with this solution, then wrung out, and washed after having become nearly dry. A mixture of sulphate of ammonia and sulphate of lime is used by some.

THE TEMPLE OF SOLOMON: ITS FORM AND STYLE OF ARCHITECTURE.

At a recent meeting of the Architectural Association, London, Mr. Edward C. Robins, F.S.A., gave a review of the various theories held respecting the form and style of architecture of the Temple of Solomon. The lecture was illustrated by numerous diagrams, plans, and conjectural restorations, some of which we reproduce.

Mr. Robins pointed out that the Jews were not a building people, and had left no native monument but what was the result of forced labor in foreign lands. The two great authorities for the construction of the Temple were the accounts in 1 Kings, chapter vi., and the Jewish historian Josephus, the former being the more reliable. Josephus was well acquainted with Herod's Temple, and might be trusted in his description of that remarkable series of buildings, except perhaps as regarded their height.

Into his account of Solomon's Temple he imported his knowledge of Herod's, and gave to Solomon the credit of much that belonged to a later age. His example in this respect had been followed by subsequent writers and expositors, and thus there had been much idle speculation which could never have arisen had the account in the Book of Kings been the accepted authority for all subsequent restorers. Mr. Robins remarked that the investigations of modern explorers had shown that Josephus had exaggerated by about fourfold the highest parts of the first temple, and that he gave full play to his imagination whenever he could safely do so, as in speaking of the depth of valleys since filled up or the height of towers since leveled with the ground. Josephus rarely contradicted the sacred Scriptures, but rather omitted or supplemented them, or else took advantage of some verbal discrepancy or peculiar mode of expression to introduce his own notions, whenever it served his purpose so to do, or tended to exalt the glory of his people Israel. Of Jewish religious structures, the earliest was the tent of the Tabernacle, the plan of which was never departed from; so that when Solomon built his Temple, in the year 1013 before Christ, he did not alter the general disposition in any manner, except that he doubled every dimension. And thus the Holy of Holies became a cube of 20 cubits, or 30 ft. by 30 ft. by 30 ft., and the Holy Place became 20 by 40 by 30 cubits, or 30 ft. wide by 60 ft. long by 45 ft. high, and so on. The temple which Ezekiel saw in vision, 575 years before Christ, was identical in its dimensions with that of Solomon. Additional courts and passages were added, of which Canina and Fergusson have each made a restoration. The second temple, as it is called, or Zerubbabel's (before Christ 520), which was built by the Jews on their return from the Captivity, likewise corresponded exactly with Solomon's building, but was shorn of its decorative splendor. The third and last temple, erected by Herod 20 years before Christ, is thus described by Mr. Fergusson:*

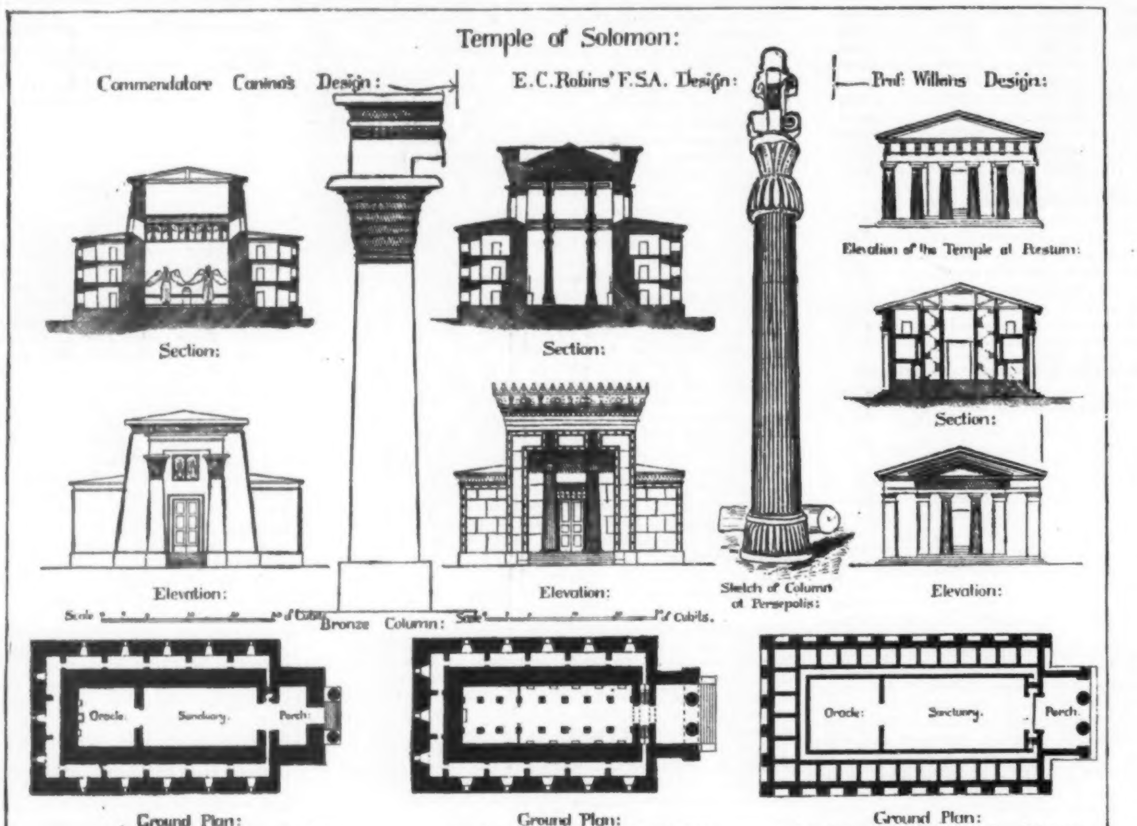
"In this we have a perfect illustration of the architectural history of the country. The priests restored the Temple itself, not venturing to alter a single one of its sacred dimensions, only adding wings to the facade, so as to make it 100 cubits wide, and it is said 100 cubits high, while the length remained 100 cubits as before.

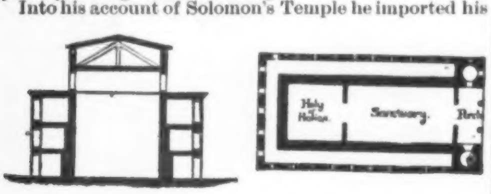
"At this period, however, Judæa was under the sway of the Romans, and under the influence of their ideas the outer courts were added, with a magnificence of which former builders had no conception. An area measuring 600 feet each way was inclosed by terraced walls of the utmost lithic grandeur. On these were erected porticoes unsurpassed by any we know of. One, the Stoa Basilica, had a section equal to that of our largest cathedrals, and surpassed them all in length; and within this colonnaded inclosure were ten great gateways, two of which were of surpassing magnificence, the whole making up a rich and varied pile worthy of the Roman love of architectural display, but in singular contrast with the modest aspirations of a purely Semitic people."

Mr. Robins regards the arguments in favor of Mr. Fergusson's views as great and manifold. The important explorations in and about Jerusalem carried on since 1864 under the auspices of the Palestine Exploration Fund are now speedily coming to a close, without having revealed anything which materially militated against the views of Mr. Fergusson, Mr. Lewin, or Mr. Thrupp, who all agreed that Herod's Temple and associated courts extended to 600 feet a side, and were situated at the southwestern corner of the sanctuary or Haram area. Solomon's Temple might have occupied the same area, as Mr. Lewin thought, or much less, as Canina and Fergusson thought, while the lecturer thought it most probable that Solomon's palace occupied the southeastern corner, where were situated the substructures, commonly called Solomon's stables. Having referred to some of the facts as to the sanctuary area brought to light by the excavation of Capt. Warren at Jerusalem, and especially to the discovery of the basement walls of masonry built into the solid rock, considerably below the present surface, on the south and east sides of the sanctuary inclosure, Mr. Robins said he should confine his attention to the position of Solomon's Temple itself. The courts surrounding it, doubtless, varied in succeeding times. Mr. Fergusson could not stretch them so far even as the present south and west walls; Mr. Lewin claimed the whole of the Haram area as we now found it, not only for Herod's time, but also for the Solomonic era, yet restricting the area of the Temple proper and its more immediate courts to the square stadium at the southwest corner—considering that the rest is included in the statement that "Solomon built Millo." Canina provides a little over 600 feet by 300, and Mr. Fergusson considerably less. Much of the eastern wall of the inclosure was evidently the work of comparatively recent times, since the remains of former buildings were built into it.

Mr. Robins next made a comparative analysis of the various designs made by different architects to illustrate the probable form and style employed by Solomon in his Temple buildings. The theories of modern antiquaries must be conveniently divided into three classes: First, the African, or those which assumed that the Temple was designed on the model of Egyptian edifices or in the Egyptian style; secondly, the European, or those which assumed that it partook of the forms and design peculiar to Grecian architecture; thirdly, the Asiatic, or those which asserted that it was to Phœnicia, Assyria, Babylonia, and Persia we must look for the style of architecture employed.

The first theory was supported by Professor Hosking, in his "Treatise on Architecture," prepared for the *Encyclopædia Britannica*, who said: "We think that the probability is great that the Temple was built in the Egyptian style, as far as the Jewish ceremonial would permit—and certainly the descriptions of its distribution accord better with that of an Egyptian than of a Grecian temple. The pillars Jachin and Boaz—which are said to have been set up before the Temple—correspond exactly in relative situation with the obelisks at the Temple at Thebes." Mr. Robins, however, held that the position of the obelisks did not answer to the description in Kings, and it also appeared to him that the very names of



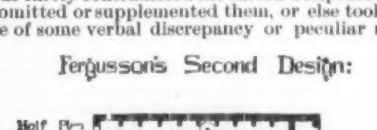


Section: Plan:

FERGUSSON'S FIRST DESIGN.

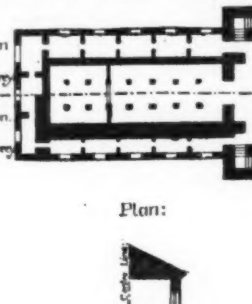
From the "Principles of Beauty in Art," for the Temple of Solomon.

Fergusson's Second Design:



Plan.—From the "History of Architecture."

Plan:



Section:

Diagram explanatory of screen Supported by the Pillars of Jachin and Boaz in Front of Solomon's Temple.

FERGUSSON'S THIRD DESIGN.

From the "Temples of the Jews."

* Mr. Fergusson's conjectural restoration of the Second Temple of Jerusalem was illustrated in the *Building News* for Sept. 13, 1878, by a double page perspective of the west front; and in our issue for April 17, 1885, we reproduced Raphael's very curious conception of a sixteen-sided edifice, ornamented by a nearly hemispherical dome, and approached on every side by a continuous flight of nine steps. It was entitled by Raphael, "The Temple at Jerusalem."

the pillars indicated their position as chief supports. The late Commendatore Canina of Rome took the Egyptian side of the question, and propounded what was certainly the most rational representation of the Egyptian theory. (A plan, section, elevation, and perspective of Canina's design are given in our illustrations.) Canina agreed with Professor Hosking that the two pillars were outside the porch of the Temple. Yet he did not suppose them to have been obelisks, but formed them into a portico in front of the porch. The nets of checkerwork and wreaths of chainwork for the chapiters, which were on the top of the pillars, seven for each chapiter, with two rows of pomegranates, 100 in a row, he supposed to have been in part the pattern of the capitals of the brazen pillars, and not a brazen network overhanging the lilywork of the chapiters, which he placed in the cornice of the entablature connecting the two columns in his design, thus forming a portico in front of the porch, alone described in Kings. The height of the true porch Canina rightly made the same as the sanctuary, but he increased the length of the sanctuary by the thickness of the wall separating the oracle therefrom; whereas, in every description in the Bible, the whole length of the house was given as threescore cubits, and the separation of 20 cubits for the oracle was afterward made. Canina's arrangement of the chambers round the house the lecturer thought most correct. Neither their number nor their length was given in Kings or Chronicles, though the former gives their width and height, while the latter does not mention them at all. The Count de Vogüé and Fergusson, in his earliest design, were misled by Josephus, who ingeniously tripled the number (ninety instead of thirty). The cubit measure was variously taken as 15, 18, and 21¾ inches long; but the successive Temples must have used the same measure. Canina's restoration did not appear to have been appreciated as it ought to have been by those who favored the Egyptian theory, and in 1855 a work was published by the Rev. Mr. Thrupp on Ancient Jerusalem, containing some singular speculations on the probable form of the Temple. The latest resuscitation of the Egyptian style was by the Count de Vogüé, but his design for the Solomonic Temple threw little light on the subject. His main facade consisted of a large Egyptian pylon, with an opening in center 20 cubits square, in which were situated the pillars Jachin and Boaz. The porch was 10 cubits deep by 20 wide, and 60 cubits high, while the rest of the massive pylon appeared to be solid, except where the staircases to the chambers occur on each side. He adopted Josephus' chambers, forming a series of dark closets, and made the Holy of Holies a cube of 20 cubits, but the height of the sanctuary was reduced from 30 cubits to 17 cubits by the introduction of an upper chamber, and thus no light could be admitted to the sanctuary or to the Holy of Holies.

Passing to the second section of the subject, the designs based on Greek styles, he would first consider the views entertained and advocated by Professor Wilkins, the author of the "Prolusiones Architectonicæ" (see illustration of elevation, perspective plan, and section of this restoration). Professor Wilkins held that a resemblance could be found to exist between Solomon's Temple and some of the earliest examples of Grecian origin, such, for example, as Pæstum and Egina. On the assumption that the Jewish cubit was equivalent to 12·888 in., the extreme length of Solomon's Temple, by a little stretching, was made (in Wilkins' restoration of it) to agree with that of the Temple of Pæstum within two inches, and to be of the same width within three inches. To achieve this result, however, passages had to be introduced to eke out the thickness of the walls of the house, and the end chambers were made deeper than the side chambers. These narrow passages in the thickness of the walls serve a double purpose; being substituted for the "windows of narrow lights." To make the total height agree with the usual proportions of a Grecian elevation, Wilkins considered the length and breadth of the house, as given, were *internal* dimensions, and the height was an *external* measure. By this arrangement he contrived to make the sanctuary and the oracle and the porch of equal external height, whereas the first was distinctly stated to be 30 cubits high, the second 20 cubits, and the third is not given at all in Kings, and was exaggerated in Chronicles by the curious multiplication of the height of each of its sides. In the number of chambers he followed Josephus, and provides 30 on each floor. As an entablature and pediment were indispensable to make the resemblance to an early Greek temple complete, Wilkins provided them in an ingenious manner, suggesting that the architectural term "epithemata," used in the Septuagint text, and translated "chapiters" in our version, properly meant some members placed over the capitals, and not only the whole entablature, but the pediment of a building also; and that the words in Kings translated "upon the tops of the pillars" should be rendered "upon the capitals of the columns."

Mr. Fergusson had also taken advantage of this suggestion, since he needed arguments to support his latest idea, viz., the likeness of the pillars and their appurtenances to the Indian toran. Mr. Hakewill published in 1851 another design in European style (see illustrations). Mr. Hakewill followed up Professor Wilkins, but was much less scrupulous than he, and defined the word "chambers" in our translation to mean "defined and limited space;" and the word "window" to stand for "means of light," and swept away the side chambers and the narrow passages, substituting a peristyle of columns for the outer walls with a wooden screen formed against them inside, which he continued all around the building, and even in front of the porch. A glance at the perspective views of this and of Professor Wilkins' design (both illustrated) would explain the difference between them.

Proceeding, in the third place, to consider the designs based on Asiatic styles, Mr. Robins mentioned that Mr. Fergusson, in his "Historical Inquiry into the True Principles of Beauty in Art," published in 1849, restored the plan and section of the Temple as he then imagined it (see No. 1 on illustrations), which was not unlike that of Canina's restoration, except that he took the height given for the sanctuary as the external instead of the internal, in which the lecturer regarded him as wrong. He also diminished the thickness of the walls, and supposed the side chambers to have been open or closed galleries incircling the house, and continuing on either side in line with its face to the front, and showed that the raised platform upon which the Temple stood was remarkably similar to those which supported the buildings at Persepolis and Passargardæ. One peculiarity which Mr. Fergusson believed to have existed, and to have formed an essential part of the fabric, was that of an upper story of wood—a talar in short—erected over the lower one in stone. While the Bible did not mention it, Josephus did, and with such circumstantial evidence to support it, that he conceived there could be little or no doubt about it. In a subsequent work, entitled "The History of Architecture," Mr. Fergusson gave another plan of Solomon's Temple, differing from his former one (No. 2 in illustrations). In this new plan he not only added the chambers instead of galleries, but placed a double row of pillars to support the roof, after the Assyrian and Persepolitan examples. He said nothing about the talar, or the two towers seventy-five feet high, but concerning the internal columns observed: "No pillars are mentioned as supporting the roof, but every analogy, as well as the constructive necessities of the case, and the fact of the existence of the two pillars in the porch, would lead us to suppose they must have existed, four in the Holy of Holies and eight in the pronaos." (See illustrations.) The latest opinions of Mr. Fergusson, after studying the subject on the spot, were given with his usual exhaustiveness and fullness of illustration in that remarkable work published in 1878, "The Temples of the Jews." In this work Mr. Fergusson maintains that the Temple of Solomon was the petrifaction of the Tabernacle extended to double the sizes, the total length being ninety cubits by forty-five, including the stone walls which did not exist in the Tabernacle, and the veranda in the Tabernacle becoming the series of small chambers surrounding the Temple three stories in height. He now gave but five chambers on each side and three at the end on each story, making thirty-nine in all; the total height of the chambers, including the thickness of the roofs, being about twenty cubits, or about the same height as the Holy of Holies. Constructional reasons gave color to his addition of internal pillars to support the roof, five on each side, and he suggested that these were the "pillars of almug trees" which Solomon made for the house, and from which Hezekiah took the golden shields to give to the Assyrians.

Mr. Fergusson was not the first, however, to suggest the internal pillars, as in an old sketch book at the British Museum, containing a drawing entitled "Young Wilkins' First Sketch of the Plan of the Temple of Solomon," and dated 1805, the pillars were shown with the tables between them. With reference to the pillars in the porch, called Jachin and Boaz, Mr. Fergusson had hit upon an original interpretation of great ingenuity, which was one of the curiosities of this, his latest work. He now considered them as detached from the front of the building, forming a screen or gateway like the vine-bearing screen described by Josephus and the Talmud as existing in front of the Temple of Herod, and based on the Japanese and Indian toran.

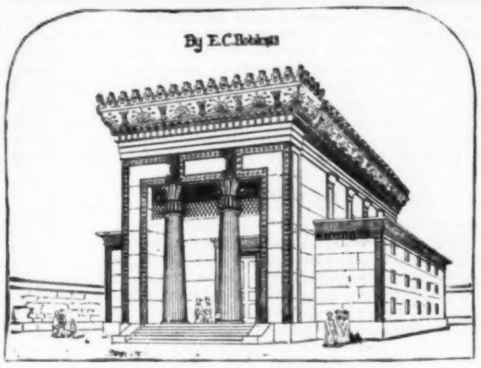
In conclusion, Mr. Robins gave his own conclusions on the subject, saying: For my own part, I think with Mr. Fergusson and Mr. Lewin that it is to Asia and not to Africa or Europe we must look for the true architectural type. Not, indeed, for the form and arrangement of the plan—this was emphatically Jewish—but for the style and forms of art adopted in details and accessories. Whatever was the character of the arts in Tyre, the Temple of Solomon partook of that character. A Tyrian architect and Tyrian artisans were employed in the design and construction of the buildings at Solomon's own request, and thus the style of art prevailing at the period in the capital of Phœnicia would, doubtless, be stamped on every part, and we are interested to know what may have been the style peculiar to Phœnicia, if, indeed, it was peculiar to it, seeing that there are no remains of native art existing which can be safely depended upon. I think that they were not indebted to the Egyptians, but rather that they drew their ideas of art from the regions whence they migrated, and with which they held important commercial relations. Their religion, too, was closely allied to the Sun and Planet worship of the Persians, Assyrians, and Babylonians, and their temple arrangements must have been very similar. The Jews came from Northern Mesopotamia, and the Phœnicians from southern Mesopotamia.

Hiram was ever a lover of David, but Pharaoh was a jealous rival, whose ambition was only temporarily satisfied by the matrimonial alliance with Solomon; and it seems scarcely probable that Hiram would have taken the same interest in the work if Solomon's Temple had been a mere reproduction of an Egyptian fane. The artists Hiram furnished to Solomon for the construction and adornment of his Temple and palace represented the skill of the nation; it comprehended every branch of art working in gold and silver, in brass and iron, in purple and blue, in stone and timber, in fine linen, and in the engraving of precious stones.

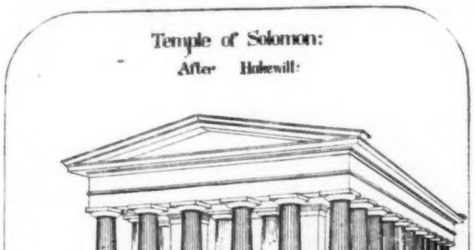
Phœnicia had inexhaustible supplies of cedar and fir. Hence it was natural that wood should be the prevailing material of Phœnician architecture, while it was almost banished from that of Egypt. All the internal work of Solomon's Temple, instead of sculpture, was carved work of olive wood, cedar, and gold. The characteristic ornaments were of native origin, as the Rev. Mr. Kenrick has pointed out. The closest approximation to what Phœnician art may have been appears to be realized only in the remains of Assyrian and Persian art. Acting upon this theory, first expounded by Mr. Fergusson, I, many years ago, linked together various architectural details, gleaned from the examples at Nineveh and Persepolis, adapting them to the requirements of the Temple of Solomon; but of course the design is but a suggestive compilation, a sort of inductive solution, yet another example in this study of architectural comparative anatomy, which I have purposely left unaltered, except as regards the internal pillars, the only addition to my original design. (See illustrations.)

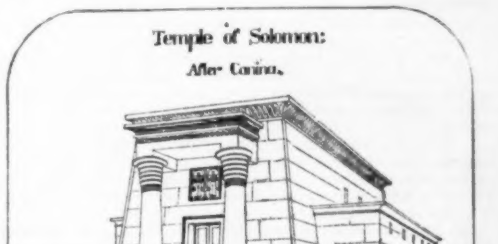
The arrangement of the pillars in the porch of the Temple is precisely similar to the Persepolitan, the brazen network and pomegranates incircling the capitals and hanging over the lilywork being most probably an original device of the Sidonians, so celebrated for their works in brass, unless we accept Mr. Fergusson's ingenious theory of an independent gateway or toran. With respect to the side chambers, the Vihara at Adjuntah and the Palace of Darius, as restored by Mr. Fergusson, make these cells appear not so singular after all; and possibly they formed a series of strong rooms wherein were stored the various utensils required at the sacrifices and services of the Temple, and may be referred to by David when speaking of the "treasuries and upper chambers and inner parlors thereof." The similarity in the masonry of the retaining walls of the platform, which is supposed to be visible at the southeastern angle and at the Wailing Place and elsewhere, to those existing at Passargardæ and Persepolis and all Assyrian buildings is very remarkable.

I have only to draw attention to the details of Assyrian and Persepolitan architecture, which I pieced together in composing the design exhibited, which, as I have said, was made by me some twenty-eight years ago; and though it does not solve the problem, it remains as a record of an early attempt to do so. (See illustrations.) The doors and windows are from the palaces at Persepolis. The upper and crowning members of the cornice are from the tomb of Darius. The lower members from the pavilion in the Khorsabad sculptures, the similarity of the arrangement of which with the porch of Solomon's Temple is remarkable. The lower cornice is from the bass-relief of El-tell-Armarna and from the stylobate of the Temple at Khorsabad. The enrichments are from the pavement and other details from ornamental pottery at Kouyunjik. The pillars are from Persepolis, with adapted capitals and network complete.—*The Building News.*



THE TEMPLE OF SOLOMON.





THE TEMPLE OF SOLOMON.

HIGH-SPEED TRACTION.

WE illustrate a high-speed traction engine built for passenger service in India by J. & H. McLaren, of Leeds. It is compound, and fitted with Messrs. McLaren's well-known spring wheels. The conditions under which it was built stipulated that it should attain a speed of eight miles an hour while hauling a load of about 2½ tons.

The following are the principal particulars: Boiler of steel throughout, except fire-box, which is of Farnley iron. Working pressure, 150 lb. per square inch.

Heating surface—

Fire-box	35·5 sq. feet.
Tubes	104·8 "
Total	140·3 "
Grate area	6·6 "
Forty-two 2 in. tubes	5 ft. long.

Cylinders—

High pressure, 6½ in. diameter, } 12 in. stroke,
Low-pressure, 10 " " } steam jacketed.

Shafts—

Crank shaft, 3½ in. diameter, 3¾ in. crank pins.
Intermediate shafts, 3¾ in. diameter.
Main axle, 5 in. diameter.
All forged steel.

Wheels—

Driving wheels, 5 ft. 9 in. diameter by 1 ft. 4 in. wide, fitted with patent springs; front wheels, 3 ft. 9 in. diameter by 10 in. wide.

Gearing—

All of crucible cast steel, arranged in three speeds.

Ratio of speeds, fast gear—

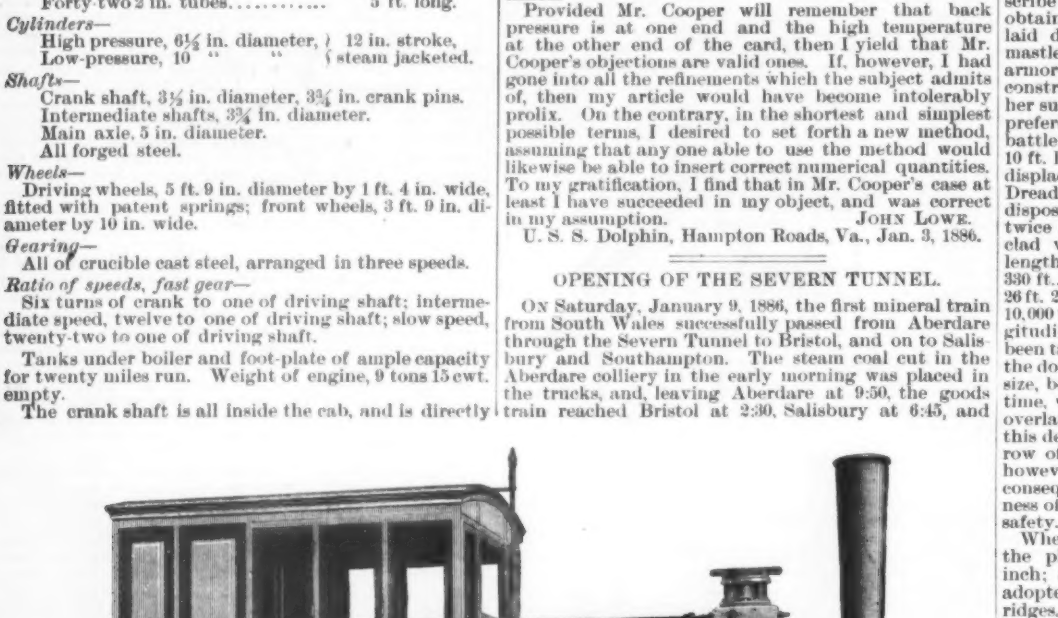
Six turns of crank to one of driving shaft; intermediate speed, twelve to one of driving shaft; slow speed, twenty-two to one of driving shaft.

Tanks under boiler and foot-plate of ample capacity for twenty miles run. Weight of engine, 9 tons 15 cwt. empty.

The crank shaft is all inside the cab, and is directly under the driver's eye; the fly-wheel is also inside the cab.

All handles, brake wheel, clutch levers, etc., are arranged within easy reach of the driver. All the clutch gears are interlocking, so that it is impossible for the driver to put in more than one set of gear at one time.

The steerage gear is arranged so that there is no backlash. The chains take hold of sectors outside the leading wheels. These sectors admit of both chains being kept tight, so that the wheels are always ready to answer to the steerage—a matter of great importance at high speeds. A few spring washers are put under the nuts at the end of the chains, which greatly assist the chains to withstand sudden shocks. Large oil-boxes are cast on the steerage sectors, from which the front wheel bushes are constantly supplied with oil. The steerage chains are secured at both ends with double nuts and split pins, all of ample dimensions. The front wheels are fitted with chilled bushes running on case-hardened axle-ends. The width of the cab inside is 6 feet 6 inches. A seat is arranged at the back end on springs, to carry four passengers. There are sliding doors at the back of the cab for taking in fuel, etc.—*The Engineer.*



HIGH-SPEED TRACTION ENGINE.

STEAM ENGINE ECONOMY.

To the Editor of the Scientific American:

The article on "Steam Engine Economy," by Chief Engineer John Lowe, U. S. Navy, in your issue of the SCIENTIFIC AMERICAN SUPPLEMENT of December 19, was read by me with considerable interest, and I think it is worthy of the attention of any engineer.

In studying the diagram, and the formula in connection therewith, I found one or two points that I failed to understand. In the first place, I fail to understand how we can assume the back pressure to be constant. We know that for the economical working of a reciprocating engine we must use compression; and since this occurs at the end of the stroke, when the pressure from expansion is decreasing, the forces acting on each side of the piston are more rapidly approaching a balance than on the commencement of the stroke.

In the second place, I fail to see why he assumes the temperature of the steam in the cylinder to be constant, when it must by its expansion become less and less, hence making the loss by radiation less and less. I have plotted the curves of gain and loss in several cases, assuming the back pressure not as constant, but as taken from an indicator diagram, and have found that the curve of losses is not a straight line, nor does it follow the general direction of the curve of expansion; but following the general direction of the curve of back pressure, it recedes somewhat toward the end of the stroke, owing to the internal temperature becoming less and less. Please state whether I am correct, or have misunderstood his description.

W. COOPER.

Evans Mills, December 21, 1885.

To the Editor of the Scientific American:

I have received your communication, inclosing Mr. Cooper's objections, which I again inclose to you, with this, my reply, both of which I would like to see published.

Provided Mr. Cooper will remember that back pressure is at one end and the high temperature at the other end of the card, then I yield that Mr. Cooper's objections are valid ones. If, however, I had gone into all the refinements which the subject admits of, then my article would have become intolerably prolix. On the contrary, in the shortest and simplest possible terms, I desired to set forth a new method, assuming that any one able to use the method would likewise be able to insert correct numerical quantities. To my gratification, I find that in Mr. Cooper's case at least I have succeeded in my object, and was correct in my assumption.

JOHN LOWE.

U. S. S. Dolphin, Hampton Roads, Va., Jan. 3, 1886.

OPENING OF THE SEVERN TUNNEL.

ON Saturday, January 9, 1886, the first mineral train from South Wales successfully passed from Aberdare through the Severn Tunnel to Bristol, and on to Salisbury and Southampton. The steam coal cut in the Aberdare colliery in the early morning was placed in the trucks, and, leaving Aberdare at 9:50, the goods train reached Bristol at 2:30, Salisbury at 6:45, and Southampton between 8 and 9 the same night, a journey of eleven hours, a remarkable feat, inasmuch as the coal cut at Aberdare in the morning could, if necessary, have been put on board a steamer that night in time for her to leave Southampton at midnight. Sir Daniel Gooch's sanguine hope of opening up the mineral traffic of South Wales by means of the Severn Tunnel has thus been realized, and, instead of carrying the coal by the tortuous route round Gloucester, or by the Severn Bridge, by which means it has recently been brought to Southampton, the Great Western Railway will now carry it direct by the South Wales and Severn Tunnel and South Wales Union Railway to Bristol and on to Salisbury, and thence by Southwestern line to Southampton.

The coal train consisted of fourteen trucks of ten tons each, and two break vans, with engine. By way of Quaker's Yard, Sirhowy Junction, Nine Miles Point, and Newport, it reached Rogiet, the Monmouthshire entrance to the tunnel, at one o'clock. It took just nineteen minutes to pass through the four miles and one-third of tunnel, two and a quarter of which are beneath the rapidly flowing Severn, at a depth of from 45 feet to nearly 100 feet below the bed of the river. To the lowest, the shoots, the gradient is 1 in 90, and the rise to the Gloucestershire side 1 in 100. The road, all of which was laid by artificial light, chiefly electric light, was found to be in admirable condition; there were no "slacks" or jolting throughout the journey, and the atmosphere was so pure that half-way through the daylight could be seen at two miles distance. At Pilning, on the Gloucestershire side, where the tunnel joins the South Wales Union line through a cutting, there was a fine display of bunting, and at many points *en route* persons assembled to see the first train through to Bristol and Southampton. On reaching Bristol at 2:30 the train had to be shunted on to the main line for Salisbury, but the loop line by which the Severn Tunnel goods trains will sweep round on to the main line without stopping to be shunted is nearly completed. The South Wales Union Railway from Pilning is being doubled for the increased traffic, and the first tunnel out of Bristol on to the main line is to be removed for the same purpose, and altogether the outlay on the Severn Tunnel and these extra works in consequence of its opening will cost the Great Western Railway 2,000,000*l*. The success of the test goods train on Saturday will lead to the goods traffic being commenced immediately; but with respect to the passenger traffic the directors will await the completion of the doubling of the line and the loop line, and the erection of the powerful ventilating fan already on the works at the Severn Tunnel—a gybul fan of 40 ft. diameter, capable of discharging 240,000 cubic feet of air per minute.

HER MAJESTY'S SHIP CAMPERDOWN.

THE new armor-clad Camperdown, which was launched last month, is estimated to cost £210,380 for labor, and £279,000 for material for the hull alone, making a total of £489,380, or in round numbers half a million of money. This is exclusive of £104,900 for engines, £180,000 for armor, £7,000 for masts and spars, and an unknown sum for guns and mountings. It will be instructive as well as interesting, says the *Times*, to describe in detail the kind of ship which the country will obtain for this immense cost. The Camperdown was laid down on the 18th of December, 1882. She is a mastless, barbette, twin-screw ship, and is the largest armor-clad, in respect of length, which has yet been constructed at Portsmouth, nor is she likely to have her supremacy in this particular contested, as a strong preference is being manifested in favor of less cumbrous battle ships. She is 5 ft longer than the Colossus, and 10 ft. longer than the Inflexible; and while her tonnage displacement is practically the same as that of the Dreadnought, the differences in her design and in the disposition of her armor enable her to carry guns of twice the weight of those carried by the older armor-clad without increase in her bulk or draught. The length of the Camperdown between perpendiculars is 330 ft., her extreme breadth 68 ft. 6 in., depth of hold 26 ft. 2 in., mean draught 26 ft. 9 in., and displacement 10,000 tons. She is built of mild steel and upon the longitudinal principle, and more than ordinary care has been taken to economize weight. The inner plating of the double bottom is exceedingly thin for a ship of her size, being only $\frac{5}{16}$ of an inch thick, and for the first time, we believe, in naval construction the plates are overlapped in the same way as the outer skin. By this device seam straps and the necessity for a double row of rivets are dispensed with. The method has, however, only become expedient and practicable in consequence of the introduction of steel and the lightness of the plates, which may now be used with perfect safety.

When iron was exclusively used in naval shipbuilding the plates were usually of the thickness of ⅝ of an inch; and had the overlapping system been then adopted, pools of water would have formed along all the ridges. For the purpose of economizing weight, the strips of metal which are placed upon the frames between the longitudinals to compensate for overlapping are pierced with seven holes, the longitudinals being all cut away when this can be done without weakening the structure. The double bottom extends for about 156 ft. amidships and is subdivided by water-tight transverse frames, placed 20 ft. apart, as well as by the vertical keel third longitudinal. Above this longitudinal the inner bottom is formed by the wing passage bulkheads on each side of the ship. Three other bulkheads, which run in a longitudinal direction, separate the space between the wing passage bulkheads into machinery and coal bunker compartments, the coal of which forms a protection for the motive power. The vertical keel piece is formed of steel plates 12 ft. in length, 38 in. in depth (except outside the double bottom), and weighing 20 lb. to the square foot, representing half an inch in thickness. The flat keel plates are worked in two thicknesses, tapering in the one instance from 25½ lb. to 23 lb. to the square foot, and in the other from 34 lb. to 23 lb.; and the vertical and flat keel plates are connected together by 4 in. by 4 in. and 3 in. by 3 in. angle steels on the lower and upper edges respectively. While the butts of the vertical keel plates are secured by double butt straps treble riveted, the butt straps of the flat keel plates are treble chain riveted, the lengths of the straps being in each case 16½ times the diameter of the rivets. The vertical keel is arranged and fitted, and calked throughout the length of the double bottom, so as to divide the latter into separate watertight compartments. The longitudinals within the limits of the double bottom are formed of plates from 16 to 20 ft. in length, and from 30 in. to 35 in. in breadth, strengthened by angle steels having flanges of 3 in. by 3½ in. and 3 in. by 3 in. on the inner edge, and from 3 in. by 3½ in. to 5 in. by 5 in. on the outer edge. Of the five longitudinals in the double bottom, three are pierced with holes within the frames 23 in. long and 15 in. across wherever the frames are deep enough to leave sufficient strength outside the holes, care being taken in lightening the longitudinals that the perforations are disposed with reference to the butts of the plating and longitudinals, so that there may be, as far as possible, uniformity of strength in each opening between the frames and facility afforded for the survey of the vessel. The remainder of the amidship longitudinals are arranged parallel throughout the length of the armor belt, and taper thence to the extremities of the double bottom. The longitudinal frames before and abaft the double bottom are formed of 10 in. by 3½ in. by 3½ in. Z bars of 20 lb. per foot, scored in over the 6 in. transverse frames, and attached to the side plating and frames. The transverse framing in the double bottom consists of solid, thoroughly watertight frames, and of intermediate frames, 4 ft. apart, formed of bracket frames and angles, except above the second longitudinal and beneath the engine bearers, where solid plates, lightened with holes, are substituted. Before and abaft the armor belt the transverse frames are formed of Z bars, 6 in. by 3½ in. by 3 in. (14 lb. per foot), and placed 3 ft. apart; above the armor deck and to the limits of the double bottom they are formed of angle bars 7 in. by 3 in. (12 lb. per foot), placed 4 ft. apart, with intermediate frames of angle bars 4 in. by 3 in. (8 lb. per foot); while behind the armor the frames are formed of a Z steel, 10 in. by 3½ in. by 3½ in. (20 lb. per foot). The skin plating is of various thicknesses. For a length of 230 ft. amidships the middle line or keel strake consists of plates 25½ lb. per square foot in the upper, and 34 lb. in the lower bottom, the strakes on each side of the keel of plating 25½ lb. to the foot, and the remainder of the side to the armor shelf of plating 23½ lb. to the foot. Behind the armor the plating is in two thicknesses, each of 20 lb. to the square foot; on the side before and abaft the armor belt it is 19 lb.; forward in wake of the chafe of the anchors it is 25 lb.; while between the

upper and main decks, in wake of the torpedo ports and between the fuel packing, it is doubled, the total thickness being not less than 2 in. It is not necessary to describe the technical devices in the shape of counter sinking and riveting, strips, straps, and rabbets, lap joints, etc., by which the whole structure is stiffened and held together; or to specify in detail the various passages, flats, and bulkheads by which the interior of the hull is subdivided. Sufficient particulars of the ship's shell have been given, but it may be profitable to inform the general reader that in determining the thickness of a steel plate from its weight per square foot, 40 lb. may be accepted as the standard of an inch.

As the Camperdown carries its heavy guns in a forward and an after barbette, and consequently far apart, the arrangement has necessiated an increased length of citadel, as compared with a turret ship, for the purpose of securing a protected communication between the magazines and the barbettes. The difference in weight, however, is compensated by a reduction in the depth of the protection required; for whereas in a turret ship the machinery employed for rotating the turrets has to to be defended by high armor, the turning gear in a barbette ship is contained within the barbettes themselves. The belt of the Camperdown extends 150 ft. of her total length, and is 7¼ ft. deep, of which 5 ft. is below the water line. This gives a protected area of 56·35 per cent., while that of the Inflexible is 42 per cent., and that of the Colossus 42·75 per cent. The armor is formed of iron faced with steel, 18 in. thick for a depth of 4 ft. from the upper edge, afterward tapering to 8 in., and is supported by a backing of East Indian teak, 15 in. thick at the thinnest part. At each end of the belt, and extending across the ship, is an armored bulkhead of the same depth as the side armor, the plating of which, however, is 16 in. thick at the upper, tapering to 7 in. at the lower part, and is supported by backing having a *minimum* thickness of 12 in. The total weight of armor on board amounts to 2,942 tons. The armor belt is connected at the top by a deck consisting two thicknesses of ½ in. mild steel and 2 in. of iron in a single thickness. Within the compartment thus formed are the engines and boilers, which may be considered as being completely protected from the ordinary projectiles of an enemy. Additional protection is obtained by the arrangement of the coal bunkers along the sides of the ship and across the ends of the citadel.

The bunkers oppose a thickness of 9 ft. of coal to the passage of shot; and between these and the outer skin are wing passages 6 ft. in width, along the inner wall of which will be placed elastic mats for arresting the inflow of water. The ends of the ship are entirely unprotected by vertical armor, a feature which, it is contended, constitutes the special weakness of this class of ships. Before and abaft the armored bulkheads, however, is the under-water armored deck, formed of two thicknesses of ½ in. plating overlaid by a single thickness of plating, 2 in. in thickness. Starting just below the water level of the bulkheads, it gradually dips forward to the stem, where it supports the ram (which is further strengthened by the 2 in. of armored bow plating), and aft to the stern to protect the steering gear. Besides affording security to the magazines, shell and store rooms, and the various compartments below, this deck insures a large amount of buoyancy and stability in the eventuality of the unprotected ends being injured or shot away in action. A considerable gain in protection is also secured by sloping the armor deck athwartship. Now, it is maintained by the advocates of the Camperdown class that a projectile striking a belted ship at the water line, where the belt is thin—although in some of the latest French ships the end armor is 18 in. thick—would penetrate the plating and get under the protective deck, which is on the top of the belt, and that there is, consequently, nothing to prevent the projectile reaching the magazine and blowing up the ship. This risk the under-water deck of the central citadel ships entirely obviates, the projectile passing through the sides. But, while this is the case, there is no reason why a belted ship should not be fitted with a lower as well as an upper protective deck. This would put the two classes on the same level as regards the security of the magazines against shot and flooding, the only difference being that in a belted ship the energy of a projectile would be spent after getting through the armor, and would probably explode between decks. In the citadel ship, the greatest danger to be apprehended in action is not so much from the bursting of shell as from the ingress of water. To provide as far as possible against the loss of stability from this cause, the spaces at the ends above the protective deck are subdivided by water-tight bulkheads and filled with coal, patent fuel, water tanks, and other stores, which serve to exclude water when the ends are penetrated. As a matter of fact, it has been calculated that with the ends riddled, and with all her stores on the protective deck in place, the sinkage of the Camperdown would be only 14 in. With half the coal and stores consumed, the sinkage, under the same conditions, would be 12 in., while with all the coal and stores consumed, the sinkage from the load line would be 10 in. Mr. Smith states that in the Admiral type a very large proportion of the unarmored upper works must be destroyed to reduce the range of stability to 30 degrees, and that when even this has been done the vessels will, in the words of the Inflexible committee, be able to face all contingencies of weather. Spaces above the underwater deck are also appropriated for a water chamber at each end. These run from side to side, and being partially filled with water, exert a powerful influence against rolling.

Standing upon, and leading up from, the main deck within the armor belt are two circular armored tubes, 21½ inches in diameter, for purposes of ventilation when in action, and for the passage to the large guns of ammunition, which is thus under protection during its whole passage from the magazines. The tubes are covered with steel-faced armor plates 12 in. thick, with a backing of 15 in. of teak worked vertically. The frames are of Z bar, 10 in. by 3½ in. by 3½ in., of 21 lb. The upper ends of the tubes are within the two barbettes, which form a distinctive feature of this class of ship. They are built upon the middle line of the ship at each end of the citadel, with which they are connected by the tubes already mentioned. The barbettes are pear-shaped in plan, and are intended to contain each a couple of 13·5-inch 68-ton B. L. R. guns, revolving upon turntables. Instead of being curved as in the ordinary turret, the steel-faced armor of the barbettes has plain surfaces. A series of angles is consequently formed at every junction of the plates, which are also sloped inward, after the manner of a glacis, at an angle of 60 degrees. The armor has a normal thickness of 14 in., except at the parts nearest the center of the ship, where it is 12 in. The plating here, however, will be to a certain extent protected by the fellow barbette, by the plating of the ship's side, and by the obliquity of the angle offered to the enemy's fire. The backing is composed of 18 in. teak. The barbettes are protected from shell bursting immediately beneath by a 3 in. floor, the loading gear and breech mechanism are protected against projectiles by the thick inclined armor, while the men are protected against horizontal fire by the barbette walls and against a dropping fire from machine guns stationed in an enemy's tops by a gun-proof cupola. In spite of these precautions, however, the protection to guns and gunners by the barbette system is inferior to that afforded by the turret, and it is not impossible that a lucky discharge of canister or case shot, while leaving the gun itself uninjured, might destroy the men in the barbette and disable the delicate breech mechanism and loading gear, which is particularly liable to casualties.

The weight of each barbette including guns and mounting is 710 tons, while the weight of each turntable and its burden is about 220 tons. The 68-ton guns will fire a projectile of 1,250 lb., and will have a powder charge of 625 lb. The auxiliary armament (as at present arranged) of the Camperdown will consist of six six-inch breech-loading rifle guns, 12 six pounder rapid firing guns, four Gardner and ten Nordenfelt machine guns, and 18 Whitehead torpedoes, which will be discharged from five above-water tubes, two on each side and one through the stem itself. The battery of six-inch guns is under a light spar deck, and is protected from raking fire by armored screens 6 in. thick, with 10 in. teak backing and frames of the same kind as the armored tubes. They stretch from the barbette walls in an oblique direction to the sides of the ship, which is composed of two thicknesses of half inch steel plates. The guns and their crews, however, will be separated from each other by transverse bulkheads, or splinter screens of plating. Standing above the after part of the foremost barbette, is the armored conning tower for the officer in command during action. This will be protected by plates varying from 12 in. to 9 in. in thickness, and further strengthened against shot and shell by 10 in. of backing. All the hatches on top of the deck over the belt that are necessarily open when fighting the ship are protected by armored glacis plates and coffer dams, which rise to a height of more than five feet above the water.

The Camperdown will be propelled by two sets of inverted three-cylinder engines constructed by Messrs. Maudslay, Sons & Field, of London, and having two high pressure cylinders 52 in. diameter, and four low-pressure cylinders 74 in. in diameter, the stroke of the engines being 3 ft. 9 in. The contract power is 7,500 horses with natural draught, and 9,500 horses when working with closed stokeholds and forced draught; but there is no doubt that on trial over 10,000 horse power will be obtained, and that the speed of the vessel will be nearer 17 knots per hour than the 16 which is expected. The general arrangement of the main engines is very similar to that of the Imperieuse, engined by the same firm. Steel enters very largely into their construction, the cylinder linings, crank bearings, and foundation frames, together with the standards for supporting the cylinders, being of cast steel, and the piston rods, crossheads, connecting rods, and nearly all parts of the working gear being of forged steel. The crankshafts and the propeller shafting are made of hollow Whitworth's compound steel. The various pumps and condensers are of gun metal, the condensers having brass tubes, with a total cooling surface of 17,000 square feet. The water is circulated through them by two centrifugal pumps, with fans 4 ft. in diameter, each being driven by a pair of small engines. There will be 12 oval boilers, arranged in four water tight compartments, each boiler being 12 ft. 4 in. wide, 14 ft. 1 in. high, and 9 ft. 11 in. long, having in all 36 furnaces, 3 ft. 2 in. in diameter, and 7 ft. long, with a collective area of fire grate of 800 square feet, and fitted with 3,432 tubes, 2¾ in. diameter and 7 ft. long. There are two oval funnels 10 ft. long in the fore and aft direction by 6 ft. wide. For working with forced draught there are eight fans, 5 ft. in diameter, each of which is driven by a separate engine; and, besides these, there are four other fans, 4 ft. in diameter, for ventilating the engine rooms, magazines, and other portions of the vessel below the steel deck. There are over 30 auxiliary engines for various purposes, most of which have two cylinders. The ship will carry 10,000 tons of coal, which it is expected will enable her to steam 1,764 miles at full power and 5,170 miles at 10 knots. She will be manned by a complement of 430 officers and men.

AN IMPROVED INDICATOR.

IN those experiments of long duration whose purpose is to ascertain the work expended in order to produce certain effects, such as the traction of vehicles and the running of machine tools, the use of an indicator that gives direct results often becomes indispensable. This is why the following study relating to the construction of such a measuring instrument is not perhaps without interest.

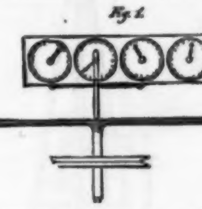
The indicator in question is the disk and wheel counter of Poncelet and Morin, which is shown in Fig. 1. This ingenious apparatus unfortunately does not always give accurate results, it having been found that its indications always represent that the work expended is somewhat less than is really the case, and that the discrepancy is so much the greater in proportion as the resistance to be overcome is more variable and irregular. The error is due to a certain sliding or slipping of the wheel over the disk that may be attributed to a couple of causes that we shall examine.

One of the causes of the sliding resides in the very nature of the surface of contact of the wheel, which, instead of being formed of a cylinder without sensible thickness, has necessarily sufficient width to permit it to resist wear and prevent it from penetrating the disk and destroying the surface thereof. Did the rolling surface of the wheel belong to a cone having for apex the intersection of the disk's plane with the axis of the latter's revolution, the rolling would be geometrically perfect. But the said surface is cylindrical, and a single point of each generatrix of the cylinder leaves the disk immediately after touching it and engenders a circle which really rolls upon the plane, and all the other points slide over the disk the more distant they get from the circle of rolling.

These slidings in opposite direction have the effect of diminishing the adherence of the wheel upon the disk, and, although the wheel has but a slight stress to overcome in order to carry along the delicate wheelwork of the counter, such stress, acting while these slidings are occurring, suffices to retard the motion of the wheel, whose velocity then becomes less than that of the mean circumference of its contact upon the disk. Such retardation in the motion of the wheel becomes more perceptible in measure as it further approaches the center of the disk. Here a sort of neutral zone is established, where it no longer revolves at all.

The other cause of the wheel's sliding is the helicoidal motion that occurs when, as a consequence of the motions of the dynamometer spring, the wheel runs

Fig. 1.

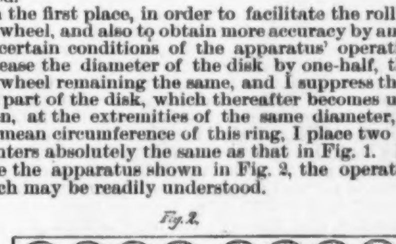


parallel with itself upon the disk. While this lateral sliding is taking place, the stress that the wheel has to transmit to the registering apparatus becomes sufficient to prevent it from revolving, or at least to retard its revolution. This is why the indications of this counter vary so much more in accuracy during the experiments in proportion as the variations in the spring's tension are more frequent.

Although they have not received the assent of practice, the following are the various modifications that I have devised for remedying the defects that I have just noted.

In the first place, in order to facilitate the rolling of the wheel, and also to obtain more accuracy by amplifying certain conditions of the apparatus' operation, I increase the diameter of the disk by one-half, that of the wheel remaining the same, and I suppress the central part of the disk, which thereafter becomes useless. Then, at the extremities of the same diameter, upon the mean circumference of this ring, I place two wheel counters absolutely the same as that in Fig. 1. I thus have the apparatus shown in Fig. 2, the operation of which may be readily understood.

Fig. 2.



During the revolution of the ring, the two wheels revolve. As they have the same diameter and roll over the same circumference of the ring, they have exactly the same angular velocity, and the counters that they actuate will mark exactly the same number of revolutions, and remain in accord so long as the dynamometer spring with which they are connected remains at zero. But when the spring comes to bend, as a consequence of the resistance to be surmounted, the two wheels will move together and parallel with each other, one of them approaching the axis of the ring and the other receding from it just as much. Their velocities will thus have varied in inverse sense to the same degree, the two counters will no longer be in accordance, and half the difference of the numbers that they indicate will give the measurement of the work transmitted; but since, after a few hours' operation, the numbers to be subtracted would be excessively large, it is well to suppress this operation and employ a differential motion. The simplest consists in revolving all the dial needles and all the dials by wheels. In this way the relative motion of the needles over the dials will be null so long as the spring is at zero, but in measure as the stress to be transmitted increases in force and duration the differ-

Fig. 3

ence between the number of revolutions of the dials and needles will become more marked, and, at the end of the experiment, it will be possible to read the exact figure of the difference of the numbers of revolutions of the two wheels. It is unnecessary to say that any other sort of differential motion might be employed.

If the arrangements that I have just indicated do not sufficiently remedy the sliding of the wheel, then it will perhaps be well to try the following one, which has the advantage of suppressing the "slowing" motions of the wheel, and also of doing away with a great portion of the stress that it has to overcome, and which makes it slide.

It consists of an annular disk over which rolls a wheel mounted in a peculiar way, as shown in Fig. 3. It will be seen that the axle of the wheel is held by an arm that is free to turn around a vertical axis situated in the plane of the wheel. This latter, which is of a hard material and a non-conductor of electricity, carries at one point of its circumference a small metallic rod which, at every revolution, bearing against the disk, closes the circuit of a pile and turns, by one tooth at a

time, a clockwork actuated by a weight or spring. This wheelwork is provided with a differential system which also acts upon a transmission connected with the disk's axle.

The apparatus having been so regulated that the needle of the dial marks zero so long as the dynamometer spring remains free, the number that it indicates at the end of the experiment is proportionate to the work transmitted.—*N. J. Raffard, in Chronique Industrielle.*

FIGEE'S STEAM PILE DRIVER.

THE apparatus shown in the accompanying engravings has been designed by its builders with a view to driving piles or walling-timber with a power varying

FIG. 1.—FIGEE'S STEAM PILE DRIVER.

from 1,100 to 2,600 pounds. The monkey consists of a cast iron cylinder with wide base, bored out throughout its entire length in order to receive the piston and its rod. This latter is hollow, as shown in Fig. 2, passes through a stuffing box in the cylinder head, and carries a three-way cock at its extremity. One of the orifices of this cock communicates with the boiler through a strong rubber tube capable of withstanding the pressure of the steam at its elevated temperature, while a second orifice serves for the exhaust, and the third corresponds to the balancing of the apparatus. The piston rod and cock are fixed by a riveted collar to a double T-iron which passes between the two posts of the monkey, and, through the intermedium of a catch

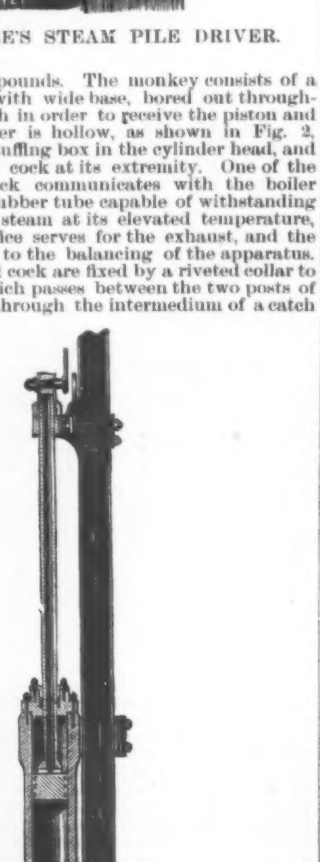


FIG. 2.—VERTICAL SECTION.

riveted to the beam, rests upon the head of the pile. This latter is held in place and guided by a slide passing between the posts and the monkey.

When steam is admitted, it flows through the hollow rod of the piston into the upper part of the cylinder of the monkey. As the piston is stationary, the monkey is forced to rise under the influence of the pressure until the moment when, upon the cock being turned, the steam is allowed to escape. The monkey then falls abruptly upon the head of the pile. When the pile has once been set, the driving is effected by simply maneuvering the cock. A steam winch, permanently attached to the carriage of the apparatus, serves for raising the monkey and placing the piles.

In favor of this system, the constructors claim the following advantages: (1) As the monkey has no side motions with respect to the pile, there is no striking of false blows of a nature to shiver the pile, while at the same time the piston rod cannot get twisted. (2) The rubber steam-tube does not follow the motions of the monkey, and thus does not become weakened so as to lead to bowstring and consequent costly repairs. (3) As the piston rod does not rest upon the head of the pile, it does not, as in some systems, pass through the base of the monkey; consequently, the condensed water cannot flow over the head of the pile and soften it—an occurrence that would prove unfavorable for the driving of the pile and its ultimate preservation.—*Le Genie Civil.*

REACTION WHEELS AND TURBINES.

By WILLIAM DONALDSON, M.I.C.E.

THE principle of action of the reaction wheel is totally distinct from that of the turbine. The name "Reaction Wheel" has probably been given to it by the inventor because the energy imparted to the water by the action of rotation causes, by reaction, an increase in the pressure at the orifice of discharge.

The machine consists of one part only, viz., a revolving receiver provided with radial arms, at the extremities of which there are placed simple orifices or special nozzles, which have their axles horizontal and at right angles to the radial arms. The reaction wheel is actuated solely by the difference between the pressures due to the discharge through the orifice and the maximum pressure at the extremity of the revolving arm acting upon an area equal to that of the orifice of discharge. The reaction wheel, therefore, is simply a water pressure engine in which there are no valves or pistons, and therefore one in which the machine friction is reduced to that of two bearings.

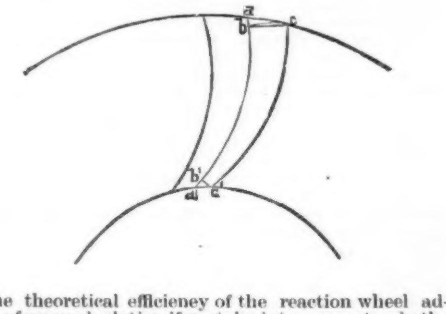
The pressure of the water in the receiver has its maximum and the relative velocity its minimum value, and, *vice versa*, at the orifice of discharge the pressure has its minimum and the relative velocity of discharge its maximum value. The absolute velocity gradually increases from zero until it acquires the velocity of rotation of the extremity of the arm of the wheel, and then suddenly, at the orifice of discharge, attains its final minimum value, which is equal to the difference between the final relative velocity and the absolute velocity of the orifice.

A turbine wheel consists of two parts, a guide blade chamber and a revolving wheel. The water issues from the guide blade chamber with its maximum and leaves the wheel with its minimum absolute velocity. In outward flow turbines and in inward flow also, which are constructed in such a way that the pressure, leaving friction out of consideration in the wheel, is constant, the relative velocity of the water may either increase or decrease as the water passes through the wheel. If the tangential velocity of the wheel, in the case of outward flow turbines, at its outer periphery, and in the case of inward flow at its inner periphery, is not greater than the initial tangential relative velocity of the water, the final relative velocity will be less than the initial, and *vice versa*, if the tangential velocity of the respective peripheries is greater, the final relative velocity of the water will also be greater than the initial relative velocity.

It is utterly impossible that statical pressure can exert any appreciable effect on producing motion in a turbine, because the area against which the fluid presses on the front face of a wheel vane cannot be greater than the corresponding area against which it presses at the back. Throughout the greater part of the length of the vane the pressures at the back and front of the vane are equal, and it is only for a short length of vane near the outer and inner periphery of the wheel that the pressures on the back and front are not equal to each other. In the case of turbines which are designed in such a way that the pressure of the water when it enters the wheel is greater than that with which it leaves the wheel, whether intentionally, as in the case of Professor Thomson's vortex turbine, or unintentionally through the ignorance of the designer, this pressure must have a retarding effect on the motion at the beginning of the stroke and an accelerating effect toward the end. An examination of the diagram shows this clearly. The diagram shows a section through three consecutive vanes of an inward flow turbine wheel, of which the top and bottom plates are parallel to each other. $c\,b$, $c^1\,b^1$ are perpendiculars from the inner and outer extremities of the third upon the middle vane, $a\,b$, $b^1\,a^1$. If equal and opposite velocities are imparted to the water and to the wheel, so as to bring the latter to rest, the action of the water relatively to the wheel will be the same as if the wheel were revolving with the assigned angular velocity. The jet will now be flowing through the guide blade passages with a steady motion, and the relations of the heads due to velocity and statical pressure will be in accordance with Bernouilli's theorem. The sum, therefore, of these heads, leaving friction out of consideration, will be the same at every section, and the greater, therefore, the height due to the velocity, the less will be the height due to the pressure. At the receiving side the pressure on the back of the arm for the length, $a\,b$, is constant, and equal to the maximum initial pressure, while the pressure on the front of the vane diminishes from the point, a, to the point, b, owing to the increase of the velocity of flow. At the discharging side the pressure at the back of the vane is constant for the length, $a^1\,b^1$, and is equal to the tail water pressure, while on the face of the vane the pressure increases from a^1 to b^1, owing to the diminution of the relative velocity. Whether the retarding effect of the pressure on the receiving side is greater than, equal to, or less than the accelerating effect at the discharging side depends entirely on the shape of the vanes, but it is quite impossible that there should be any appreciable difference between the two. Clearly then the whole of the work in a turbine is produced by the impulsive action of the fluid against the vanes, and the sections of the guide blade and vane passages ought to be so designed that the water ceases to be under any other pressure than that due to the tail water the instant it leaves the guide blade chamber.

The vane itself ought to be so designed that as little as possible of the energy of the current is lost in altering the temperature of the water and the turbine. The water should strike the vane without shock, and should leave it without tangential absolute velocity. The best turbine is simply a perfect Poncelet wheel. I have discussed this question at great length in my work on water wheels, and am confident that the arguments therein stated in favor of my views are unanswerable.

The effective duty obtainable from a turbine must be very much less than the tangential energy of the water when it leaves the guide blades. Impact and friction cause change of temperature and consequent loss of total efficiency, and from the total efficiency there have to be deducted the work done in overcoming friction of bearings and resistance of the air or of the water, according as the turbine is working in the air or is submerged in the tail water. If α therefore be the angle at which the guide blades cut the tangent to the wheel periphery, the coefficient of efficiency must be much less than $\cos.^2\alpha$. In very few turbines is this angle less than 20 deg., for which $\cos.^2\alpha = 0{\cdot}89$. If $\alpha =$ 10 deg., $\cos.^2\alpha = 0{\cdot}97$. The smaller the value of α, the greater will be the difficulty in constructing a theoretically perfect turbine, and therefore the greater the liability to loss of total efficiency. This loss of total efficiency, and therefore the sum of the losses due to friction of bearings and resistance of the atmosphere or tail water, cannot be ascertained experimentally. It has, however, been ascertained that nearly 25 per cent. more duty can be got out of a turbine working in the air than out of a turbine working in the water. If, therefore, we deduct this difference from the value of $\cos.^2\alpha$, we shall obtain a limiting value of the coefficient of efficiency, which we know a turbine with its wheel working submerged can never reach. For the reason already stated, 20 deg. may be looked upon as practically the minimum value of α, so that deducting 0·25 from 0·89, the value of $\cos.^2$ 20 deg., we get 0·64 as the limiting value. From this have to be deducted the loss due to working in the air, since 25 per cent. is the difference only between working in the air and working submerged and the loss in total efficiency. It is clear, then, that the net efficiency of a turbine working submerged must be less than 50 per cent. of the net initial energy of the water, and of a turbine working in the air less than 70 per cent. The great difference between duty of a turbine working with its wheel drowned and in the air is due not only to the greater frictional resistance of the water, but to the creation of eddies in the wheel passages owing to their being filled with water under the pressure due to the head of tail water.



The theoretical efficiency of the reaction wheel admits of easy calculation if we take into account only the net head due to maximum pressure at the extremities of the arms, and leave out of consideration all losses due to friction and eddies in the water before it reaches the orifice of discharge. The rotation of the wheel will produce an angular velocity in the water which will be equal to that of the machine itself at every point, both in the receiver and in the arms, so that the water will enter the arms from the receiver under exactly the same conditions as if the wheel were at rest. The net pressure due to the fall will be increased by the head due to the centrifugal force, and the work done in producing this head will in part be given back by increasing the total work done by the water.

Let Q = cubic feet of water discharged per second.
W = weight of a cubic foot of water.
R = radial distance in feet of the center of the orifice of discharge from the axis of the wheel.
ρ = ditto ditto of any other point.
ω = angular velocity of rotation per second.
a = area of orifice.
H = height due to maximum pressure in radial arm arising from gross fall.

In passing from the center to the end of the radial arm, each particle of water acquires the angular velocity $\omega\,R$, and, therefore, acquires the kinetic energy $\frac{\omega^2\,R^2}{2\,g}$, or the whole work done per second in producing the angular velocity of rotation will be equal to $\frac{W\,Q\,\omega^2\,R^2}{2\,g}$.

The centrifugal force exerted by a lamina of thickness $\delta\,\rho$ and area, equal to one square foot at the distance ρ from the center, would be equal to $\frac{W\,\omega^2\,\rho\,\delta\,\rho}{g}$, and the total centrifugal force opposite the center of the orifice of discharge, being equal to the sum of the forces exerted by all the lamina, would be equal to $\frac{W\,\omega^2\,\rho^2}{2\,g}$ per square foot, or the height due to pressure would be equal to $\frac{\omega^2\,\rho^2}{2\,g}$. The potential energy therefore acquired by the water in a second being equal to $\frac{W\,Q\,\omega^2\,\rho^2}{2\,g}$ is exactly equal to the work done in imparting to it the tangential energy. The total height due to pressure at the extremity of the radial arm is $H + \frac{\omega^2\,R^2}{2\,g}$.

There are three cases to investigate:

I.—Straight arm with simple orifice of discharge at side.

II.—Straight arm with especial nozzle designed to make loss of head due to discharge a minimum by making area of orifice coincide with area of *vena contracta.*

III.—Curved arm with special nozzle.

CASE I.—SIMPLE ORIFICE.

If we, as a first step, leave out of consideration the cause and effect of the angular momentum imparted to the water, the work done per second will be equal to

$$W\,c_2\,H\,.\,a\,.\,\omega\,R = \frac{W\,Q\,c_1\,H\,\omega\,R}{c_2\sqrt{2\,g\,H}}$$

since $Q = c_2\,.\,a\,.\,\sqrt{2\,g\,H}$, where $(1 - c_1)\,H$ is the head lost in resistance at the orifice, and c_2 the coefficient of discharge. We can only determine the value of c_1 by actual experiments with orifices of different shapes. With the orifice described in Case II., we should have $c_1 = c_2$ and the work done equal to $\frac{W\,Q\,H\,\omega\,R}{\sqrt{2\,g\,H}}$. The maximum value of $\omega\,R$ cannot exceed the velocity of the water in the *vena contracta*, which we may take to be equal to $0{\cdot}9\sqrt{2\,g\,H}$, and should not be less than $c_2\sqrt{2\,g\,H}$. Assuming 0·62 for the value of c_2, the total efficiency of the machine would be equal to from 60 per cent. to 90 per cent. of the gross power.

When we take account of the cause and effect of the angular momentum of the water, the total work done per second is equal to

$$W\,c_1\left(H + \frac{\omega^2\,R^2}{2\,g}\right).\,a\,.\,\omega\,R = \frac{W\,Q\,c_1\,\omega\,R\sqrt{2\,g\,H + \omega^2\,R^2}}{2\,g\,c_2}$$

$$\text{sin. } Q = c_2\,a\sqrt{2\,g\,H + \omega^2\,R^2}.$$

In order to arrive at the net effective work done by the water exclusive of the work done in producing the angular velocity of the water, it will be necessary to deduct from the above the value of the latter, or $\frac{W\,Q\,\omega^2\,R^2}{2\,g}$, and we have for the value of the net total effective work done the expression

$$\frac{W\,Q\,c_1\,\omega\,R\sqrt{2\,g\,H + \omega^2\,R^2}}{2\,c_2\,g} - \frac{W\,Q\,\omega^2\,R^2}{2\,g}$$

which reduces to

$$W\,Q\,H\left\{c_3\,K\sqrt{1 + K^2} - K^2\right\}$$

if we put $\omega\,R = K$ and $c_3 = \frac{c_1}{c_2}$.

It has been ascertained by experiment that the efficiency of a machine provided with the nozzle described in Case II. is greater than that of a machine with a simple orifice, therefore c_1 must be less than c_2. It must be greater than the value given by the equation $c_3\,K\sqrt{1 + K^2} - K^2 = 0$, from which we get

$$c_1 = \frac{c_2\,K}{\sqrt{1 + K^2}}.$$

The limiting values of K will be given by the equations

$$\omega\,R = K\sqrt{2\,g\,H} = 0{\cdot}9\sqrt{2\,g\,H\,(1 + K^2)}\ldots.(1)$$

$$\omega\,R = K\sqrt{2\,g\,H} = 0{\cdot}62\sqrt{2\,g\,H\,(1 + K^2)}\ldots.(2)$$

From (1) we get $K = 2 \quad c_1 < 0{\cdot}55$

From (2) we get $K = 0{\cdot}62 \; c_1 < 0{\cdot}2$.

It is clear, therefore, that with a simple orifice the velocity of the orifice can never be equal to $2\sqrt{2\,g\,H}$. If $\omega\,R = \sqrt{2\,g\,H}$, or $K = 1$, we have $c_1 < 0{\cdot}44$, which corresponds with a loss due to obstruction at orifice equal to 56 per cent. of the whole head. That is clearly in excess of what the actual loss can be. Therefore in the case of a simple orifice the velocity may be equal to $\sqrt{2\,g\,H}$. It is impossible to calculate the theoretical total efficiency without a knowledge of the value of c_1.

CASE II.

When nozzle is so designed that the area of the orifice corresponds with that of the *vena contracta*, the loss of head due to friction of discharge is exactly counterbalanced by any increase in the area of discharge, so that we have for the total efficiency the expression—

$$W\,Q\,H\,(K\sqrt{1 + K^2} - K^2)$$

since $c_1 = c_2$.

When $K = 2$, the coefficient of efficiency is therefore equal to 0·45, and when $K = 0{\cdot}62$, the coefficient is equal to 0·34. This difference of 11 per cent. would probably be much more than counterbalanced by the increase of the work done in overcoming friction and atmospheric resistance, the former of which would be equal to $2 \div 0{\cdot}62 = 3{\cdot}2$ times, and the latter to $(3{\cdot}2)^2 = 10{\cdot}3$ times the value of these items in the case of $K = 0{\cdot}62$. If $K = 1$, the coefficient of efficiency is equal to 0·4.

CASE III.—CURVED ARM.

Since the curvature of the arm cannot add anything to the effective moving force acting on the arm, there can be no advantage in adopting a curved arm beyond that of diminishing the resistance of the air on the back of the arm. With a straight arm and a nozzle at right angles to the arm, the greater part of the velocity of approach would be destroyed by impact and eddies; but if the arm is curved, the loss of velocity of approach will be due to friction only. When, therefore, the head due to pressure is very small, and the height due to velocity of approach very great, the velocity of the orifice may be greater than it could be if the final relative velocity of flow were due only to the sum of the pressure heads, but there will be no increase in the total effective work of the machine, because the moving force being proportional directly to the area of the orifice, and the area of the orifice being inversely proportional to the velocity of flow, the product of the moving force multiplied by the velocity will be constant, so long as the pressure is constant, whatever may be the value of the velocity.—*The Engineer.*

ON THE VENTILATION OF SEWERS.*

UNTIL the last twenty or thirty years it was not the general custom to ventilate sewers, and most of the main sewers themselves were constructed without manholes or ventilators, the branch sewers often discharging into cesspools, the overflow from which was connected with the main sewers, the cesspools being, as far as practicable, hermetically sealed, and seldom emptied, the consequence being that the stagnant sewage was decomposed, and the germs of disease rapidly spread.

The numerous cases of typhoid and kindred diseases arising from these defects in works of drainage caused sanitary reformers to awake to the dangers arising from pent-up sewage, and it was then sought to send the sewage away as far and as quickly as possible, and outlets were provided for the escape of the sewer gas both from cesspools and sewers.

The modern French system has been based somewhat on this system, the cesspools themselves being made as air and water tight as possible, with upcast shafts to take the sewer gas from the cesspools, and the soil pipe carried down from the top of the house with an outlet to the air at the top and the bottom, extended below the surface level of the liquid retained in the cesspool as a trap. This system, called the *fosse fixe*, is sometimes connected with a sewer, sometimes not, and, of course, especially in the latter case, involves periodical and frequent cleansing, and this necessity has caused the invention of several ingenious arrangements for emptying the *fosse fixe* or cesspool; but this system is much more costly than the English system, owing to the large annual cost both of cleansing the cesspool and carting away the soil; otherwise the effect, where the work is scientifically and well executed, and the emptying and cleansing constantly attended to, is to keep the sewer gas from being discharged within the dwelling; but much more sewer gas is generated than in the English system of constant flow, and the annual cost is about five times the cost of removal by water, or about 12s. 6d., as compared with 2s. 6d. per head per annum in the case of large towns.

The main sewers in France, and generally abroad, are, as a rule, very badly ventilated, and their construction is often such as to favor the generation of large quantities of sewer gas, discharged often by gullies and other openings immediately under the nose of foot passengers.

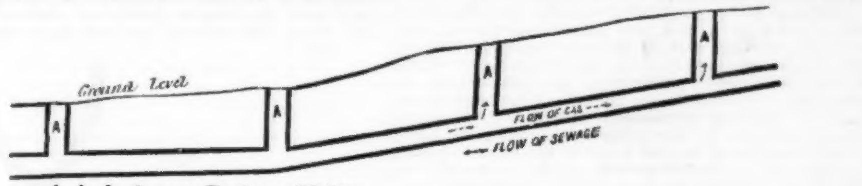
In England, the sewers, as far as their liability to generate sewer gas is concerned, have been generally much better constructed than abroad, and of much smaller dimensions than the French, and better proportioned to the normal flow of sewage, filling, consequently, at all times a larger portion of the sewer, and the sewage runs with a greater and, for the sewers, more self-cleansing velocity. Sewers so constructed also expose a smaller proportionate surface of sewer wall to the alternate wetting by sewage and drying and decomposition which takes place especially at certain seasons of the year, and dry weather follows after a storm; thus the English sewers are better constructed to air, generation of sewer gas, and better cleansed, but until recently very little has been done in the way of ventilating the sewers except by the insertion of a greater or less number of stink outlets, and next to nothing has been done to render sewer gas escaping at these blowholes innocuous, nor until recently has much been done to assist in the cleansing of sewers in a practical manner, and it is needless to inform engineers that it is absolutely necessary to keep sewers clean, either by natural or artificial flushing, and for this purpose, where a sewer is laid with a flat gradient, much more is needed than an occasional flush at a few points, from a 500 or 1,000 gallon self-acting flush tank, the flush from which in a sewer of moderate size is spent in a very short distance. Most sewerage engineers who have turned their attention to the ventilation of sewers have contented themselves with making the stink outlets or ventilating manholes at intervals of from about 65 yards and upward, the distance generally adopted being over 100 yards, the idea being that the sewer gas discharging at these outlets would be sufficiently diluted with atmospheric air to render it innocuous. The author's own practice has been of late to place ventilating manholes 200 feet apart as a convenient distance for examination, and quite far enough for the free circulation of air which the author seeks to secure in every sewer.

As the age of sewers has increased all the defects due to defective private house drainage, and connections of house drains with the sewers have become apparent, and the smells from some ventilating manholes have so increased that public opinion has been roused, even to the extent of compelling the stoppage of ventilators instead of adding to their numbers, the public, generally in a time of excitement and fear of microbes and bacilli, acting upon the principle that what the eye does not see or the nose smell the heart does not grieve at.

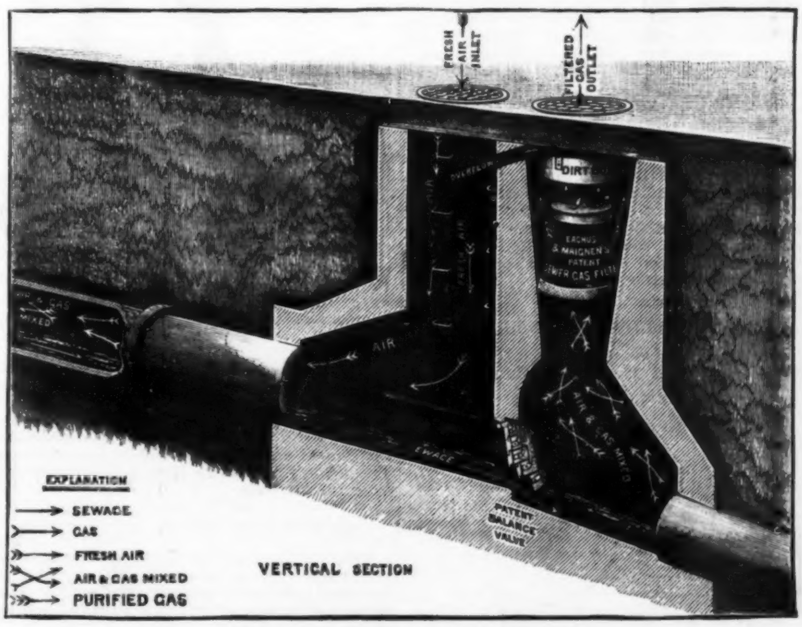
When ventilators were first introduced, many attempts were made to filter the sewer gas before allowing it to discharge into the open air, and many and complicated were the ventilators patented, charcoal being generally the substance employed to filter the gas; but owing partly to the charcoal being often so displaced when the filter was put in that the sewer gas could pass freely through the open spaces, partly owing to the ventilators being so constructed that the charcoal was constantly wet and clogged, so as not to act properly; owing to these and other causes, these charcoal trays and filters have gradually come into disuse.

Various attempts have also been made to create strong upcast draught by furnace chimneys, cowls, or other artificial means, but these attempts have never been more than locally, and then only very partially, successful.

The author having himself encountered most of these practical difficulties, tried a number of experiments at his own house, and on sewers under his charge, in order to test by the practical and elementary sense of smell (which is the test put by the public), rather than by delicate anemometers and other means, when and under what conditions the sewer gas was most freely generated and discharged. The next point was to ascertain how the flow of sewer gas could be so regulated as to prevent undue accumulation at any one point, and how the papers by the ventilators could be relieved of the constantly unpleasant smell experienced at many places. The result of these experiments was to show that a well-constructed sewer, with a moderately quick fall and constant flow, running from one-third to one-half full or more of sewage generated the least quantity of sewer gas; also that a sewer similarly constructed, with a similar fall, seemed to form the best channel for the conveyance of sewer gas; and for this reason where practicable the author of this paper prefers to have a sloping outlet up which the sewer gas may ascend, so as to arrive at its point of discharge with the least possible obstruction. More sewer gas was found to be generated in the larger and badly constructed sewers, especially in those with flat fall and varying flow, and where the velocity of flow is insufficient for the sewer to be self-cleansed. The sense of smell is, of course, most apparent when the necessary conditions of stagnation and comparative temperatures of the sewer and of the air happen to meet, and hot fluids entering the sewers always add to the aroma and increase the difficulty of dealing with the gas.



A. A. A. Ordinary Ventilating Manholes



MODE OF VENTILATING SEWERS.

The flow of the gas and the sense of smell both seem to travel as a rule in the direction inverse to the flow of sewage, but this rule is by no means without exceptions. For the purposes of this paper, it is, however, better to deal with the general rule, which is that sewer gas when generated travels upward, and tends to accumulate in the upper districts at points where there is some check to the flow, or some local circumstance to make a ventilating manhole a good upcast shaft. The author had a good case in point, where a clean, new, well-laid sewer, with a rather quick fall and no sewage in it, served as an admirable ventilating shaft for an old sewer.

To prevent this accumulation of sewer gas, to dilute the gas with atmospheric air, and to filter the diluted

* Being a paper read by Mr. George Eedes Eachus, M. Inst. C. E., to the Civil and Mechanical Engineers' Society on 16th December, 1885.

gas before its discharge, the author, in conjunction with Mr. Maignen, the well known patentee of the *Filter Rapide*, has taken out a patent for localizing the sewer gas, diluting it as much as possible and filtering it through a charcoal filter in such a way as to overcome the disadvantages above referred to. The accumulation is prevented by localization, and this is effected by means of double or divided manholes, provided with stops or valves placed at the lower part of the middle division in each manhole. The model and drawing show the general arrangement by which the air is allowed to enter the sewer through that part of the manhole called the air inlet. The air passes up the line of sewer, mixing with the sewer gas as it travels, until it comes to the valve or stop at the next manhole, which prevents its further progress and turns it through the filter out at the ventilating cover or gas outlet. This valve or stop is made in sections, being hung like a balance valve on a common spindle and working independently of each other, so that while the sewage flows freely down the sewer, the flow of gas in the opposite direction is arrested and diverted up the gas outlet at each manhole.

In trying to ascertain the velocity and force with which sewer gas travels the author has not yet met with great success, but he finds that except with large differences of temperature or sudden variation in flow the current is hardly perceptible, and yet without any perceptible current of gas there may be very strong smells perceptible at many ventilators. This would appear to be due to the diffusion of the gases which always takes place, rather than to an actual current, and this will be readily understood by reminding the members of the experiment, which shows that if a heavy gas is placed in the lower half of a closed vessel and a light gas in the upper part, the two parts divided by plaster of Paris, the gases are found to diffuse, even passing through a considerable thickness of plaster of Paris to mix one with the other.

In carrying out this system the author prefers, where practicable, instead of having the outlet of the upcast shaft at the surface of the road, to conduct a pipe by easy lines up the side of a house or other convenient place. Where this can be done, it is not essential in many instances to filter the sewer gas; but where it cannot be done, the author has found, after nearly twelve months' experience, that the filter of the form shown effectively does away with any objectionable smell from the sewer gas, the charcoal cannot be displaced to allow the free passage of the gas, and both the form of the filter and the overflow of the water provided in the dirt box prevent the charcoal becoming wet or damp even after many months' use.

A very similar arrangement to that above described has been used by the author in the drainage of the Town Hall, Edmonton, and there is no difficulty in the general application of the system for house drainage as well as sewerage.

The author is an advocate for trapless closets and drains, and for the straightest possible lines of soil pipes and ventilating pipes so as to maintain a free circulation from each air inlet to the adjoining gas outlet, and the air ought, in the author's opinion, to have a free circulation through every foot of sewer drain and soil pipe.

The system can, in most cases, be easily adapted to existing arrangements of sewerage and house drainage.

It has now been in work adjoining the Town Hall, Edmonton, for twelve months, and for nearly nine months in another street at Edmonton, and Mr. Laws, the engineer, of Newcastle, who saw the model at the exhibition this year, when it was awarded a medal, has been twice to Edmonton to inspect its working, and intends trying it in certain places in Newcastle which have hitherto given trouble.

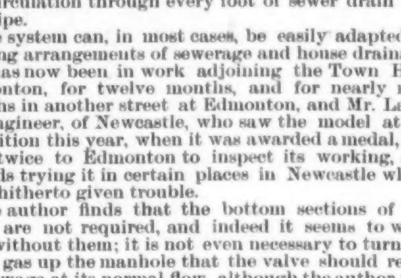
The author finds that the bottom sections of the valve are not required, and indeed it seems to work best without them; it is not even necessary to turn the sewer gas up the manhole that the valve should reach the sewage at its normal flow, although the author prefers that it should nearly, if not quite, touch it.

No stoppage or heading up of either of the sewers when it has been used has taken place, although one of them has only a fall of 4 ft. in a mile.

In concluding this paper the author would again call attention to the fact that under this system no lodgment or deposit can take place between the closets in the houses and the final outlets, the circulation of both air and water being free throughout, and the whole system of sewers is so divided into sections that there can be no accumulation of sewer gas at any one point. What there is is well diluted with air, and well filtered before it escapes into the atmosphere.

BRAY AND HEALD'S ECCENTRIC.

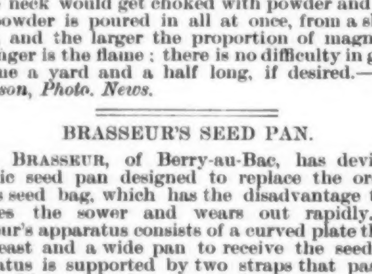
A NOVEL construction of eccentric, recently brought out by Messrs. Bray and Heald, of 2 East Parade,



Leeds, is illustrated in cross-section and front view by the annexed engravings. Although originally designed for the purpose of actuating the dabbing brushes of Nobel's wool-combing machines, to which it is now being applied, this eccentric possesses advantages which would recommend its adoption for other purposes. Referring to the figures, it will be seen that upon the shaft is keyed a disk having an eccentric boss. The edge of the disk is beveled off toward the inner side. A second disk is mounted on the shaft, the hole in it being in a corresponding position to the hole through the boss of the first disk. Between these two disks fits a hoop, the edges of which are beveled to correspond to the beveled edges of the disks. The two disks are connected together by means of a bolt and nut. In order, however, to prevent the disks nipping tightly on the hoop, a washer or collar is fitted on the bolt between the disks. As the disks and hoop wear on their beveled edges, this collar is correspondingly reduced in thickness, so that the nut may be screwed up tight without nipping fast the disks and hoop. An annular or C-shaped space is thus left inside the eccentric, which, after being loosely packed with cotton, wool, or felt, is filled up with oil. When the nut is properly tightened up, it is impossible for the oil to escape between the beveled edges, and the eccentric runs for several weeks without requiring a fresh supply. The wear is reduced to a minimum.

A MAGNESIUM LIGHT FOR PHOTOGRAPHY.

THE brass vessel, A, is of the size of an egg-cup. The neck, B, of the spirit lamp is so placed that the falling sand and magnesium just clear the end of the wick, but leave the hole of the cup in, or very near, the



flame, E; for unless the hole be kept hot, water from the flame will condense in it, and the powder adhere thereto. The hole in the cup should be as big as a pea, or larger. A funnel will not do in place of the cup, as the neck would get choked with powder and water. The powder is poured in all at once, from a sheet of paper, and the larger the proportion of magnesium, the longer is the flame; there is no difficulty in getting a flame a yard and a half long, if desired.—*W. H. Harrison, Photo. News.*

BRASSEUR'S SEED PAN.

MR. BRASSEUR, of Berry-au-Bac, has devised a metallic seed pan designed to replace the ordinary canvas seed bag, which has the disadvantage that it fatigues the sower and wears out rapidly. Mr. Brasseur's apparatus consists of a curved plate that fits the breast and a wide pan to receive the seed. The apparatus is supported by two straps that pass over the shoulders, after the manner of suspenders.

The apparatus may be of zinc, tin plate, galvaniz-

ed iron, or any other suitable metal. It is very readily carried. The straps are regulated according to the sower's stature, and, in order to prevent them from slipping, there is arranged at their crossing point a leather band which is fixed by its extremities to one of the straps, and through which the other strap passes. The sower's hands are thus left entirely free.—*Chronique Industrielle.*

MANUFACTURE OF SULPHURIC ACID.

THE economical manufacture of sulphuric acid does not require great chemical knowledge, but close attention and tact are required. The acid is either derived from the fumes of burning sulphur or from roasting either iron or copper pyrites. As arsenical pyrites are frequently found, the fumes from burning the sulphurets of iron or copper are sometimes poisoned by arsenious acid, which is not present generally in so large an amount as to affect plant life. Since on the large scale the pyrites acid can be made more cheaply, after the expensive manufacturing plant is once erected, and while the fires are kept up for a year or more at a time without the addition of anything but the raw material, the waste copper has an added value after removing the sulphur, hence these pyrites plants are destined to be used more extensively. Still there are many important questions in economy which are not yet answered in a manner satisfactory to manufacturers, and in the present depressed price of the article new inventions are not being developed.

The acid from sulphur will always be required for manufacturing, chemical, and pharmaceutical purposes, since the one business of soda water alone requires thousands of carboys a week, and the suspicion of an arsenical taint would ruin a soda manufacturer's occupation.

The pyrites are burned in a series of roasting furnaces, when properly made, set in brick and detached many feet from wood. The furnaces are charged at the top with the rock every few hours, night and day, for a series of months, the sulphuret supplying its own fuel, and the metallic waste is drawn out at the bottom. One of the very latest burner houses has a tile roof, resting on slats, supported by trusses of heavy timber reaching from wall to wall. Very often the burner-house itself is frame, but in all cases it should be brick and detached. When sulphur is used as the source of acid, it is thrown on a flat hearth, called "the sole," heated underneath by a coal fire. In either process nitrate of soda is placed in a cast-iron pot, in order that the nitrous acid fumes may mingle with the sulphurous gas. Chemists will explain the action of the nitrate of soda as giving out various items, with a waste product of sulphate of soda, but generally manufacturers insist that its presence cannot be fully explained, since it only acts as a reagent or a middle-man, hastening the conversion of sulphurous acid fumes into sulphuric acid. In a few cases the fumes pass into a small receiving chamber, but rarely directly into the large acid chambers, through large lead tubes or iron pipes lined internally with fire brick. The fire hazard of the use of direct lead pipes consists in the thinning of the pipes by gradual action of nitrous acid, until minute holes allow the escape of hot gases upon the wooden slats or jacket used to support the pipe.

The customary method is to employ the Glover tower for the reception of the fumes from the burner; but if this is filled with coke, as in one famous instance, the gases raised to a temperature of several hundred degrees will ignite the fuel, causing a destructive fire. In all cases the "tower" should be filled with quartz blocks or imported fire brick. The action of these blocks is to retard the rapid current of gaseous vapor and to hasten the processes of condensation and of transformation of the various chemical atoms.

The receiving chambers are constructed of lead, and generally in the same building as the burners and towers; but prudent manufacturers now build the chamber-houses one hundred feet distant, with a large leaden pipe to conduct the gases from the tower into the chamber. In a few cases the buildings are brick, but in the majority of instances the construction is entirely frame. Since the manufacturers can take down their old chambers and can receive new lead plates at only the expense of rerolling, there is a general representation of the possibility of large salvage in case a lead chamber was destroyed by fire; but the experience of underwriters is that the lead melts down and flows into the ground, and little saving is made.

The chambers are generally constructed either as a series of closed rooms, communicating with one another by conduits eighteen inches in diameter, or, in some English acids works, lead curtains reach almost to the floor, causing the gas to pass behind one drop after the other. Steam is admitted into these chambers, and the well-known avidity of the sulphur gases for water results in the deposit of the acid in liquid form, where its density is measured by the Baume graduated scale —"chamber acid" varying from 46° to 50°.

From the chambers the waste gases are generally returned to a Gay-Lussac tower for saving the nitrate, where they are met by sprays of acid and washed down. Formerly this resulted in so great a saving that only eight per cent. of the nitrate was used, and now some enthusiastic men claim they have reduced the proportion to two per cent., but better chemists claim some factors in the problem have been overlooked, and that three and a half per cent. is very good economy.

This matter is of interest to underwriters, for it indicates the closeness of economy in manufacture and the degree of success attained in business during the present low price of commercial acid. Then, too, the purity of the air surrounding the chambers is an important indication, for if one cannot pass by the leaden rooms without a stifling feeling and frequent coughing, and the manager says this is unavoidable, it should occasion no surprise that fire walls are imperfectly built and fail to pass through roofs, as is frequently found in unskillful management.

The hazards of the business consist much more in little things than in the peculiarities of manufacture. In no class of business offered to insurance companies is it more important to investigate the moral hazard, both with regard to "the friction of the pocket-book" and respecting the care taken to maintain friendly relations with the residents of the neighborhood. Acid works can be a marked nuisance, causing their banishment from any settlement, or they can be so conducted as to be comparatively inoffensive. As a rule, they stand rather isolated, and the work is conducted day and night by a few men, who can receive little practical assistance from outside. Of course, there are exceptions, where sulphuric acid manufacture is carried on in substantial brick buildings, with burner and boiler houses almost fireproof and enjoying the protection of an organized and well-drilled fire brigade, with ample fire appliances, and also promptly reached by a public fire department.

The handling of the manufactured acid is another very serious consideration. Often it is shipped in carboys which are packed within the works, and the hay hazard ought to increase the rate. A still safer plan is the reception of the acid into a strong iron egg, lined within, whence by pneumatic pressure it is forced to distant works, barges, movable or stationary tanks, whence it is drawn off through pipes without any human handling.

The dangerous use of oily waste at pumps is altogether too frequent, for the workmen do not seem to be well-trained machinists, and they have too much faith in the counteracting power of acid, and begin to think there is no danger when they find a piece of wood, long saturated with acid until it has largely lost its fibrous character, cannot be burned even under the boilers.

The question of lighting is one of the most serious matters, and the incandescent electric light has not yet been introduced, from fear that the destructive fumes of sulphur would quickly destroy the insulation. For an exhibition of poor lamps and of lanterns imperfectly constructed and wretchedly guarded, we may well turn to acid works. For that matter, lantern manufactur-

ers have not yet done themselves much credit in offering a lantern for the use of workmen which is safe, convenient, and brilliant; but this matter cannot be treated now.

Storage is an important item. Generally, the lead chambers are in buildings forty-five to fifty feet high, the timbers resting on high brick piers, and the ground floors being either earth or plank. The notion prevailed at one time that economy required lofty and large rooms, but this is now conceded to be an error, and the considerable elevation from the ground can only be ascribed to the facilities for drawing off the acid by gravity. Prudent manufacturers are now requiring the space under the lead chambers to be left entirely vacant, but the chamber-house is apt to be a conglomeration in the basement of a carpenter shop, machine shop, storehouse for sulphur, and a convenient receptacle for lumber, old and unused machinery, workmen's clothing, empty wagons, and almost anything which cannot be placed more conveniently elsewhere, and sometimes a large heap of bags of nitrate of soda.

As a rule, underwriters have waged a very successful warfare against nitrate of soda, and probably the strongest chemical firm in Philadelphia now switches a car over a brick vault, mainly underground, and empties the bags through a scuttle. Nitrate of soda in bulk in brick buildings occasions no harm, and one superintendent says he manufactured powder in the interior of Pennsylvania and handled hundreds of tons of nitrate of soda without the least anxiety. This was used in making "giant powder," since saltpeter was too expensive. Yet it is in the bags that the main danger appears to lie. They are generally the perquisite of the superintendent, who formerly obtained seven cents a bag, then half that price, and now only two cents. Then, too, less nitrate is used in more economical manufacturing, and for the pittance of four cents a day the superintendent will wash the bags, dry them as best he can, and pile them in nitrate of soda storerooms or in some frame outhouse. When the attention of the proprietors is called to this matter, they nearly always order the bags to be thrown into the river as soon as emptied.

One manager, whose whole place is a model of neatness, says there is no danger from nitrate of soda kept in bulk on a brick floor, within brick walls, and under a tile roof. But it strongly resembles saltpeter in chemical constitution, and if fire is communicated to the bags and water is thrown thereon, a severe explosion will result. Incidentally, attention must here be called to the use of nitrate of soda by fertilizer mixers producing damp goods and an inferior fertilizer. These manufacturers often store nitrate of soda in frame buildings as carelessly as they do konite, sulphate of lime, or any harmless article.

The model acid works will be built of brick buildings with brick or cement floors on the ground; the steam-boiler and burner houses will each be detached. The burner plant will be built entirely free from the buildings, with commodious space on all sides, and the fumes will be received in a lined brick chamber before passing into the Glover tower, which will be a distinct structure. The brick chamber-houses will not exceed thirty-five feet in height, and will be fully detached. All roofs will have a framework of iron slats on iron trusses, the whole being well treated with an asphalt coating. The slates will be wired to the iron slats with fine copper wire. The location will be within corporate limits, affording the protection of a public fire department, and there will be a private fire pump with constant steam supply, a liberal arrangement of private hydrants, good supply of rubber hose on running reels, liberal supply of filled fire pails, a private brigade drilled twice a month, and an ample water supply independent of that afforded through corporation hydrants. In addition to night workmen, there will be a patrolman sending in signals from regular stations to a district telegraph station or to an electric clock. Lighting will be done by incandescent lights in chamber-houses and arc lights in burner-houses. Such acid works might not contribute heavy premiums to insurance companies, neither would they greatly endanger contiguous property, but underwriters would find them decidedly more profitable than under present arrangements.

Neither are these ideas Utopian, for some of these favorable conditions can be found in various works, and the model construction in the future will combine the various elements conducive to safety.—*Insurance World.*

ADULTERATION OF SWEETMEATS.

ONE of the chief forms under which fruits are consumed is that of preserves. By this name is designated every dry or liquid jelly, and every marmalade or compound obtained by cooking fruits or their juices in concentrated sugar sirup. Such aliments should possess the taste of the fruit that forms the base of them, and be composed normally of cyrstallizable sugar, glucose, pectic acid, pectine, and the acids and essences that are peculiar to the species of fruit elaborated.

By very reason of the importance of this branch of industry, the manufacture has given rise to the most ingenious adulterations. The report of the Municipal Laboratory of Paris, for 1885, gives some important data upon this subject, to which it is well to direct the attention of chemists and consumers.

It frequently happens that the sweetmeats put upon the market are totally factitious, and contain not a trace of fruit. In 1879, Mr. C. Menier analyzed a so-called currant jelly, which was in reality formed of gelose, glucose, cochineal, and chemical essences. Any one of the five following elements may be adulterated: The fruit, the jelly, the saccharine materials, the coloring matter, and the flavoring.

The fruit is often factitious. Hassal states that in England there is carried on an extensive manufacture of orange marmalade out of turnips, and of preserved apricots out of pumpkins.

Jelly, which was formerly made from gelatine, is now manufactured out of certain algæ. A jelly is also obtained by treating certain plants—especially carrots—with boiling water and adding starch to them.

The adulteration of saccharine materials is not very important. They are replaced by artificial glucose, which has the inconvenience of not being very sweet, but which is far from being unwholesome.

The coloring matters are the objects of reprehensible frauds, cochineal, archil, saffron, hollyhock, pollen, etc., having often been detected.

But it is especially the flavor characteristic of the different fruits that is oftenest imitated, this being done by means of "bouquets" that are entirely chemical. The composition of some of these is as follows:

Essence of Plum.

Glycerine	8 parts.
Acetic ether and aldehyde	5 "
Oil of persico	4 "
Butyric ether	2 "
Formic ether	1 part.

Essence of Currant.

Acetic ether	5 parts.
Tartaric acid	4 "
Benzoic acid	1 part.
Succinic acid	1 "
Benzoic ether	1 "
Aldehyde and œnanthic acid	1 "

Essence of Raspberry.

Acetic ether	5 parts.
Tartaric acid	5 "
Glycerine	4 "
Aldehyde	1 part.
Benzoic ether	1 "
Amylbutyric ether	1 "
Œnanthic ether	1 "
Nitrous ether	1 "
Sebacylic ether	1 "
Succinic ether	1 "
Formic ether	1 "
Butyric ether	1 "
Acetic ether	1 "
Methylsalicylic ether	1 "

Essence of Pineapple.

Amylbutyric ether	10 parts.
Butyric ether	5 "
Glycerine	3 "
Aldehyde and chloroform	1 part.

Essence of Melon.

Sebacylic ether	10 parts.
Valerianic ether	5 "
Glycerine	4 "
Butyric ether	3 "
Aldehyde	2 "
Formic ether	1 part.

Essence of Apple.

Aldehyde	2 parts.
Amylvalerianic ether	10 "
Chloroform	1 part.
Acetic ether	1 "
Nitrous ether	1 "
Oxalic acid	1 "
Glycerine	4 parts.

Essence of Pear.

Acetic ether	5 parts.
Amylacetic ether	1 part.
Glycerine	1 "

Essence of Cherry.

Benzoic ether	5 parts.
Acetic ether	5 "
Glycerine	3 "
Œnanthic ether	1 part.
Benzoic acid	1 "

Essence of Peach.

Formic ether	5 parts.
Valerianic ether	5 "
Butyric ether	5 "
Acetic ether	5 "
Glycerine	5 "
Oil of persico	5 "
Aldehyde	2 "
Amylic alcohol	2 "
Sebacylic ether	1 part.

Essence of Apricot.

Butyric ether	10 parts.
Valerianic ether	5 "
Glycerine	4 "
Amylic alcohol	2 "
Amylbutyric ether	1 part.
Chloroform	1 "
Œnanthic ether	1 "
Tartaric acid	1 "

In order to preserve these falsified products (not always an easy thing to do, on account of the complex materials that enter into their composition), antiseptics, such as boric, salicylic, and oxalic acids, are added to them in large proportions.—*Le Genie Civil.*

SEPARATION OF ZINC FROM ALL THE METALS OF ITS GROUP.

By W. HAMPE.

FOR separating zinc from iron, nickel, cobalt, manganese, and aluminum, the author recommends the conversion of the metals into formiates, and the treatment of the solution with sulphureted hydrogen. While the zinc is completely precipitated, manganese and aluminum, nickel, cobalt, and iron, are said not to be thrown down, provided that the solution contains a sufficiency of free formic acid (at least 15 to 20 c. c. of acid at 1·2 sp. gr. to 250 to 500 c. c. of liquid), and that such metals are not present in too large quantity. Otherwise traces of foreign sulphides accompany the zinc sulphide, and their presence may be easily known by the reddish-brown color of the precipitate Iron falls most easily in this method, nickel and cobalt less readily. These impurities are quantitatively very trifling. For their entire removal the filtered and washed precipitate is dissolved in nitric acid, supersaturated with ammonia, then with formic acid, and finally reprecipitated with hydrogen sulphide. Such a repetition of the precipitation—though by no means invariably necessary—would deprive this method of its chief advantages if there were not a means of making the zinc-sulphide capable of rapid and easy filtration. To this end Hampe passes hydrogen sulphide into the hot solution, zinc sulphide is then deposited as a granular sulphide, which admits of rapid and clear filtration and washing. As washing-liquid he uses sulphureted hydrogen water, to which have been added a little ammonium formiate and formic acid.

On passing hydrogen sulphide into the hot solution a little zinc sulphide—perhaps 1 milligrm.—is deposited so firmly on the side of the beaker that it cannot be rubbed off. After rinsing out the glass this film is dissolved in a little nitric acid, and the solution is joined to the main quantity if the precipitation is to be repeated. If this is not necessary, the nitric solution of that film is mixed with ammonia and ammonium sulphide, and formic acid is then added until the reaction is acid. The mixture is then poured upon the washed precipitate on the filter.

When dry the zinc sulphide is not horny and brittle, like that precipitated from an acetic solution, but pulverulent. Hence it can easily be detached from the filter without fear of loss.—*Chemiker Zeitung and Zeitschrift f. Anal. Chemie; Chem. News.*

THE SEPARATION OF THE CINCHONA ALKALOIDS.

By Y. SHIMOYAMA.

FOR the determining of the quinine in the mixture of alkaloids obtained by extraction, the author places at least 0·5 grm. in a beaker, and dissolves it at a gentle heat by the addition of a minimum of very dilute acetic acid in 30 to 40 c. c. of water. When the solution is cold, it is filtered into a tared beaker, the filter carefully washed, and the filtrate neutralized with a very dilute soda-lye. If any insoluble substance separates out, the liquid is filtered through the smallest possible filter, and the filtrate is mixed with a suitable proportion of a solution of sodium oxalate saturated at 18°. One c. c. is required for every 0·1 grm. of the mixture of alkaloids taken for analysis. The liquid is evaporated on the water-bath down to 8 to 10 grms., until a distinct separation takes place on cooling. From 10 to 15 c. c. of water are then added to the contents of the beaker, and the whole is stirred until the smeary mass which separated out along with the precipitate of oxalate is completely dissolved. The beaker is then set aside for three hours at 18°, stirring frequently. The weight of the contents of the beaker is determined, the precipitate is filtered upon a double filter, washed several times, with the aid of a filter pump, with a solution of quinine oxalate saturated at 18°, rinsed with 50 c. c. of a saturated solution of quinine oxalate into a capacious flask, well shaken for 15 to 20 minutes, and set aside for two hours at 18°, shaking from time to time. The precipitate is collected upon a double filter, which has been dried at 110°, and weighed and washed with a saturated solution of quinine oxalate, using a filter pump. The moist filter with the precipitate is weighed between watch glasses to ascertain the quantity of the saturated solution of quinine oxalate contained in it, dried for three hours, and weighed again. If for every grm. of the difference of weight ascertained (quantity of water of the saturated solution of quinine oxalate) we deduct 0·00069 grm. from the obtained quantity of dry quinine oxalate, we obtain the quantity of the precipitated quinine oxalate. If the latter is subtracted from the ascertained weight of the contents of the beaker, we find the weight of the mother-liquor. By multiplying its weight in grms. with 0·00064, we obtain the quantity of the quinine oxalate which remains in solution in the mother-liquor, which must then be added as a correction to the weight of the separated salt. One grm. quinine oxalate represents 0·878 grm. quinine. In the determination, the above mentioned temperature must be carefully adhered to, as even small fluctuations of heat produce considerable differences in the results. If the total quantity of the alkaloids contains only 20 per cent. of quinine, the separation of the oxalate sometimes only begins after two to three hours. For the complete separation of the quinine oxalate, it is important to stir the liquid frequently. If the quinine is less than 20 per cent. of the total alkaloids, this method is not applicable.—*Archiv der Pharmacie and Zeitschrift fur Analyt. Chemie; Chem. News.*

QUALITATIVE DETECTION OF FATTY OILS IN MINERAL OILS.

By F. LUX.

IF ordinary rape oil is heated with potassium, sodium, or solid potassium or sodium hydroxides, saponification ensues, which is in general promoted by agitation. At the temperature of 100°, and a time of action of about thirty minutes, there is formed in case of potassium, sodium, and sodium hydroxide some flocculent soap like matter; the oil, on cooling, remains mobile. Potassium hydroxide occasions no change.

If the oil is heated for thirty minutes to 150°, potassium and sodium occasion the formation of a soapy matter, and the oil remains thin on cooling. Potassium hydroxide yields a plentiful flocculent deposit which thickens the oil. With sodium hydroxide there is little deposit, a part of the soap formed dissolving in the oil, which thus begins slightly to gelatinize.

If the mixture is heated for twenty minutes to 200°, the potassium is more thickly covered with flakes of soap, the oil remains liquid; sodium is similarly coated, and at the same time the oil begins to gelatinize on cooling. With the hydroxides there is abundant saponification, and the oils on slightly cooling congeal to turbid, tough masses.

If submitted to a temperature of 250°, rape oil gelatinizes perfectly, even in five minutes, alike with potassium, sodium, and their oxides. The soap as it is formed dissolves at once, and the globules of potassium and sodium retain a metallic luster. In fifteen minutes the saponification has progressed further, while in case of potassium, sodium, and potassium hydroxide there sets in an incipient decomposition, which is recognized by the darkening and even browning of the oil. The oil which is in contact with these three agents congeals to a brown butter-like mass. Oil in contact with sodium hydroxide congeals to a hard yellowish white mass which does not darken.

Pure mineral oils, if treated in a similar manner, turn, as a rule, rather darker, but undergo no perceptible change in their state of aggregation.

Upon these observations the author founds a process for detecting admixtures of mineral oils with fatty oils. Forty series of experiments were made to test the method, the materials used being rape, linseed, and olive oils, with ordinary petroleum and two distinct lubricating oils. One of these latter (A) was thick,

opaque, of a deep blackish brown color, and a specific gravity of 0·915 at 15°; it contained 35 per cent. of hydrocarbons boiling below 350°. The other (B) was moderately thick, transparent, of a light brownish yellow color, and had the specific gravity 0·905 at 15°. It contained only 4 per cent. of oils boiling below 350°.

These oils were tested in various mixtures at different temperatures and for different times and otherwise under different conditions, and with the following results:

1. The most suitable temperature is about 200°, and the most suitable time about fifteen minutes. At temperatures below 200° the saponification proceeds more slowly, while above 200° there begins a gradual decomposition of the soap which has been formed, so that small quantities of fatty oil may escape notice. Fifteen minutes are necessary for very small quantities of fatty oils, but they are quite sufficient; with larger quantities (from 10 per cent. upward), from two to five minutes are sufficient.

2. Of the alkaline metals and their hydroxides, the most suitable is sodium hydroxide, and after this metallic sodium. The latter is more suitable for the detection of small quantities of fatty oils in mineral oils which contain a large proportion of hydrocarbons boiling below 350°, as the anhydrous soap formed on its use dissolves more readily in the volatile hydrocarbons than the hydrated soap formed from sodium hydroxide, which, at the temperature of 200°, is more apt to separate out in flocks than to dissolve in the oil.

3. To detect with certainty small quantities of fatty oil, it is better to avoid all stirring or shaking both during heating and cooling. On the one hand, the currents produced by heating suffice to bring all parts of the oil in contact with the sodium or the soda, and to distribute the soap which has been formed in the entire liquid. On the other hand, the soapy matter, formed when at rest, remains more in connection, the jelly is more coherent and tougher, while on shaking there is formed a more finely grained and flowing jelly, which is with difficulty distinguished from the real liquid. In a transparent oil, this half gelatinized state is more readily observed than in an opaque oil.

4. Even during the heating it is possible to decide with a high degree of probability whether a mineral oil is free from fatty oils or not. If the fatty oil is more than 10 per cent., the characteristic odor of soap appears very distinctly during heating, and remains after cooling. The little bubbles of gas or air which escape from the soda or the sodium and rise to the surface disappear at once in pure mineral oils. But if fatty oil is present, they remain for some time, as a rule even after cooling, since they are rendered somewhat coherent by the soap which is formed. In transparent oils this phenomenon is more easily observed than in opaque ones, in the former case with a percentage of even one-fourth per cent. of fatty oil.

5. If in these experiments we make use of ordinary test-tubes of 15 to 25 mm. in diameter, there is formed on cooling, at the surface of mineral oils mixed with fatty oils, distinctly perceptible funnel-shaped depressions.

6. The gelatinization of mineral oils containing fatty oils takes place at rather high temperatures. Thus an American petroleum containing 10 per cent. of rape oil congeals at 190°, with five per cent. at 170°, and with 2 per cent. at 130°. These temperatures can be determined only approximately, as the transit of a body from the liquid to the gelatinous state takes place very gradually, not within sharply defined limits like the transition of a body from the liquid to the solid state. Hence, enticing as the prospect may seem at the first glance, it will scarcely be possible to found a method for the determination of the fatty oils upon the observation of the gelatinizing point.

7. The limits of the detectibility of fatty oils in mineral oils are not the same for all mineral oils (and perhaps also not for all fatty oils), but with all the combinations of the oils above mentioned a proportion of 2 per cent. of fatty oil can be shown with absolute certainty either by means of caustic soda or sodium.

The following method is therefore founded on the basis of these results:

A. Preliminary experiment, or method for the detection of large quantities of fatty oil, 10 per cent. and upward.

Pour 5 c. c. of the sample into a test tube and add a fragment of caustic soda, heat to a boil over the naked flame, and keep it at that temperature from one to two minutes. If large quantities of fatty oil are present, they are recognized by the peculiar odor, and certainly by the coagulation of the liquid which ensues on slight cooling.

As if fatty oil is present its quantity is rarely less than 10 per cent., the investigation will generally be herewith concluded, *i. e.*, if the result is affirmative. If it is negative, we pass over to—

B. Detection of smaller quantities of fatty oils, down to 2 per cent.

We take two beakers of moderate size, one of which can be inserted in the other, so as to leave a distance of 1 to 2 cm. between their bottoms. In the larger is put so much melted paraffin that when the narrower glass is inserted the paraffin rises a little more than half height in the narrow annular space between the two. Into the inner glass is then poured so much paraffin that the two bodies of liquid rise approximately to the same height. In this manner there is obtained a paraffin bath, in which an overheating of the liquids contained in the test-tubes, such as there might occur in a single beaker, is rendered impossible, while at the same time a perfect observation of the behavior of the oil is rendered practicable. A thermometer suspended in the inner beaker shows the temperature, which is kept at about 200° to 210°.

Two test-tubes receive each a few c. c. of the oil in question. To one are added a few parings of sodium, and to the other a rod of caustic soda, which must be about 1 cm. beneath the surface of the oil. The two test-tubes are then inserted in the paraffin bath, and the time is noted. They are left at rest in the bath for fifteen minutes, lifted out, wiped clean from the adhering paraffin, and placed to cool.

If the mineral oil in question contains even as little as 2 per cent. of fatty oil, it congeals on cooling in one or in both tubes—generally in both—to a more or less cohesive jelly. The test-tubes may then be inverted without anything escaping, and only on strong shaking are portions of the gelatinous mass detached.—*Zeitschrift f. Analytische Chemie; Chem. News.*

A NEW OPERATION FOR THE ALLEVIATION OF PRESISTENT DEAFNESS.

By WILLIAM H. BATES, M.D., New York.

MANY cases of deafness are not benefited by thorough catarrhal treatment, inflation of the middle ear, the use of Siegle's otoscope, an artificial opening in the drum-membrane, division of the tensor tympani, etc. I desire to call the attention of the profession to an operation which has benefited a number of these obstinate cases.

The operation consisted in puncturing or incising the drum-membrane in from five to ten different places. Simple punctures were made, or the drum-membrane was slit in various directions. The operation was repeated as soon as the openings in the drum-membrane had healed. The size and freedom of the incisions must be determined after the first operation for each case.

For the operation I employed a Graefe cataract knife with a long shank. It is important that the knife be *sharp*, and to make this certain I often used a freshly sharpened knife for each puncture. Pain was avoided by this precaution. A dull knife, or the paracentesis instruments sold in the shops, caused more pain than the patients could bear.

Cocaine was not necessary when the knife-blade was in proper condition, and this remedy would not prevent pain when the knife was dull.

The result of this operation is to leave a number of cicatrices in the drum-membrane; the subsequent contraction of these producing a tension by which the membrane is drawn out. The membrane frees itself from adhesions in this manner, and in many cases loosens the anchylosed ossicles. The various benefits of paracentesis, as formerly employed, are not only obtained, but much increased. It is not an improvement the result of a perforation of the drum-membrane alone, which, as is well known, is often doubtful and transitory, but the subsequent healing of the openings is part of an improving process. The operation, suggested by that of paracentesis, differs from it in the simultaneous number and extent of the incisions as well as in the purpose for which it is resorted to and in the immediate and subsequent results.

CASE I.—J. M——, aged fourteen, resident of Boston, presented himself at my office, July 8th, 1885. Deaf in right ear since childhood. Has had measles, scarlet fever, and cerebro-spinal meningitis. Has been seen and treated by specialists in Boston. Examination: Drum-membrame depressed, thickened, congested, adherent to the promontory from chronic catarrh of the middle ear, Eustachian tubes congested. Hearing distance for snapping of finger-nails, two inches. Hears no conversation, whisper, or watch. Inflated readily. Hearing distance not improved by inflation.

July 18th.—Thorough treatment of the catarrh with inflation of the middle ear had improved the hearing distance at the outset, but this limited improvement was again lost, In view of the etiology of the ear trouble, and still further from the unsatisfactory result of the routine treatment, and the apparent hopelessness of these cases, even in hands more skilled than mine, I was much discouraged. I then determined to make a paracentesis, but one more general than usual.

July 19th.—I made three incisions in the drum-membrane.

July 20th.—My patient heard better; and on examining the drum-membrane I found my punctures healed, and, while the membrane seemed less congested, it also appeared a little less depressed. With nothing to lose, and perhaps something to gain, I now made bold to make six free incisions into the membrane, hoping for a possible continuation of the improvement. These incisions healed over as rapidly as before; and on the succeeding days, each day found the hearing improved, with an apparent diminishing depression in the membrane. It now occurred to me that the wounds in healing seemed to draw upon the membrane, and that the cicatrices were acting as elevators.

On July 25th, the membrane having healed I made a single but very large incision into the drum, and then proposed to await devolopments. Daily the hearing improved, until, on August 10th, I found the drum-membrane was healed. Examination revealed that the hearing distance for the watch in the right ear had risen to 18 inches (the same for the left ear), which under favorable surroundings was ten feet.

The patient was seen and kindly examined by Dr. Pomeroy, who recognized the hearing distance for watch at 18 inches. The patient remained under observation until August 16th; improvement had remained and increased. He now returned to his home out of town.

January 13th, 1886.—A written communication of this date informed me that the improvement has persisted.

CASE II.—N. L. J——, male, aged thirty, merchant, native of United States, came under observation at the time that I had met my first encouragement in Case I.

July 21st.—Began treatment. Complained of noises in both ears, and of constant vertigo. Examination revealed no hearing in left ear. In right ear heard snapping of finger-nails at two inches. Drum-membranes depressed, thickened, congested, and adherent to the promontory. Made four free incisions in both drums.

Treatment repeated six times, and on August 9th he passed from observation. On this date the tinnitus was much improved, the vertigo had disappeared. Hearing distance in both ears for snapping of finger-nails, six inches.

Two months later the improvement was reported as continuing.

CASE III.—C. H——, German, aged thirty-four; very nervous man. Complained of noises in both ears. Examined, and found to be suffering from chronic catarrh of the middle ear.

October 15th.—Heard watch in right ear, two and one-half inches; nine inches in left ear.

October 16th.—One incision in right drum-membrane.

October 17th.—One incision in right drum-membrane.

October 21st.—No better. Incisions were made in both drum-membranes.

October 29th.—Noise in left ear had stopped entirely. Incision in right drum-membrane.

December 4th.—Noises in right ear a little better. Five incisions were made in the right drum-membrane.

January 11th, 1886.—Incision made in the right drum-membrane.

January 14th.—Three incisions were made in the right drum-membrane.

January 15th.—The noises in the left ear have not returned. The noises in the right ear are very much better, and have stopped occasionally. The hearing is better for conversation. Patient appears less nervous.

The succeeding case presents some features of unusual interest. It was in the person of a *deaf-mute*, who seemed intelligent.

CASE IV.—B. R——, female, aged seventeen; had scarlatina and measles in early infancy, was never able to speak, but appeared observing and intelligent. Is a fairly developed girl. Has been treated three months at one of our public institutions by a most competent specialist without result. Examination revealed chronic catarrh of the middle ear. The drum-membrane was depressed, thickened, congested, adherent to the promontory.

October 3d, 1885.—Began treatment. Hearing distance for the snapping of finger-nails, four inches for the right ear, one inch for the left ear. Conversation not heard.

October 4th.—Five incisions were made in both drums.

October 6th.—Both drum-membranes healed. Hearing distance improved.

October 7th.—Four incisions in the right drum-membrane, two incisions in the left.

October 8th.—Hears better.

October 9th.—Three incisions in the right drum-membrane.

October 12th.—One incision in the right drum-membrane. Left drum-membrane not healed.

October 14th.—One incision in the right drum-membrane.

October 15th.—Left drum-membrane healed; incised.

October 17th.—Two incisions in the right drum-membrane.

October 19th.—One incision in the right drum-membrane.

October 20th.—Left drum-membrane incised. Hearing lowered immediately after the operation.

October 22d.—Hears snapping of finger-nails two inches with both ears.

October 29th.—Hears snapping of finger-nails six inches with both ears. Five incisions were made in the left drum-membrane; hearing reduced to two inches.

November 1st.—Right drum-membrane healed. Left drum-membrane open. Hears nails with right ear twenty inches; five inches with left ear. Inflation did not improve.

November 26th.—Hears watch half an inch with both ears.

December 7th.—Three incisions were made in the left drum-membrane.

January 6th, 1886.—Three incisions made in the right drum-membrane.

January 11th.—Five incisions were made in the left drum-membrane.

January 13th.—Hears watch at least six inches with both ears. Hears conversation and whisper. Since hearing was restored it became necessary to teach patient language, and she is now, under careful tutelage of her guardian, learning the rudiments of speech, her own name, the names of common objects, etc., etc.

With as yet a limited experience and the comparative brief time which has elapsed since I have first performed this operation, its full scope and range has not yet been determined.

That I have benefited some apparently incurable cases I can, with becoming modesty, honestly contend. In the light of the classical treatment of chronic cases and its frequent failure, this innovation, which has given results as unexpected and satisfactory to me as to the patients, may be fairly presented for future indorsement. To Dr. O. D. Pomeroy I extend most sincere thanks for kind corroboration as to the hearing of some of the above cases. In conclusion, I beg to state that all of the cases have been seen and examined by observers besides myself.—*Medical Record.*

MICROCOCCI OF MALARIA.

IN the volume for 1884 of *Fortschritte der Medicin*, Herr von Schlen states that he found in the blood of a malaria patient, in an early stage of the fever, both in the red corpuscles and lying free in the blood among them, round blue granules from 0·5 to 1 μ (micromillimeter) in diameter, as well as ring-shaped bodies about double that size, with intermediate stages between them, but no bacilli. From the blood of chronic malaria patients there was obtained by culture on the third day a whitish bacterial growth, consisting entirely of micrococci about 1 μ in diameter.

In the soil and water of malarial regions, Herr von Schlen found, besides various moulds and micrococci, the following three forms of bacillus: (1.) A delicate bacillus, 3 μ long by 0·75 μ broad, the cells sometimes united into short threads, but usually single and motile. (2.) Thicker bacilli, 4 μ by 1·5 μ, growing into gelatinous colonies and without motility. (3.) A very delicate bacillus 2 μ long by 0·25 μ broad, which takes only a slight stain with aniline dyes. In addition to these there were invariably found micrococci from 0·5 to 1 μ in diameter; and the author regards it as probable, though not yet demonstrated, that these micrococci are the cause of malaria.

A SINGULAR ACCIDENT.

THE following rather curious case is related by Dr. A. A. Hamilton in the *Indiana Medical Journal* for September, 1885:

"One Sunday in July last, a young man, a farmer, aged eighteen or nineteen, was quietly resting upon a lounge in his father's house, sleeping, perhaps, or dozing. While thus reposing at full length upon his side, another young man approached the sleeper, and in a playful manner gave him a box or blow upon the side of his head, over the right ear, with his open hand. An uneasy sensation, with slight pain, was experienced for a few moments, but this feeling soon disappeared, and the occurrence was, in a manner, forgotten for some three or four days, when it was noticed that there was a slight discharge from the injured ear, together with

some difficulty of hearing on that side. He thereupon presented himself at my office for examination. Suspecting the character of the trouble to be rupture of the membrana tympani, resulting from concussion or sudden compression of the atmosphere, I directed him to gently inflate the middle ear by Valsalva's method, whereupon the exit of air could be both heard and felt. He was then directed to carefully abstain from further efforts at inflation, and to remain as quiet as possible, in hope that the torn membrane would reunite. This it has failed to do, however, thus far."

OUR EARLIEST LEBANON CEDARS.

The history of the Lebanon cedar since it has been an object of culture in this country is probably more interesting than that of any other ornamental tree of exotic origin. During the comparatively brief period that has elapsed since it was first planted in Europe, it has been intimately connected with the history of modern gardening. No tree has had so much attention bestowed upon it, none has been nurtured with such fostering care, and no tree has imparted such a distinctive character to the garden landscape as the cedar of Lebanon. Its stateliness of growth, absolutely different from that of any other tree, was at once recognized by the tree planters of a few generations ago. To our tree-loving forefathers we are indebted for the noble tree growth that is now so important a feature in many of our finest gardens, and to their forethought some 200 years ago are we also indebted for our magnificent cedars. But where are the cedars that planters nowadays mean to bequeath to generations yet to come? One may travel throughout the length and breadth of these islands, and meet with but very few young specimens of the cedar of Lebanon that will take the place of the venerable examples that must at no distant date fall victims to the ravages of time.

Where are we to look for successors to the cedars at Warwick Castle, Goodwood, Pains Hill, Gunnersbury, Linton, Gatton, and a few other places? True, at Warwick there are some half grown cedars that will in time occupy the place of the grand trees whose ponderous boughs overhang the Avon; but in nine places out of ten where old cedars exist there are none to be seen to take their place. In all probability, the numerous old cedars that are now to be found in English gardens are the outcome of a short-lived fashion, such as that which obtains nowadays of planting all kinds of coniferous trees, whether suited to the climate or locality or not. No doubt it was the correct thing about a century ago to have at least one or two cedars of Lebanon about the house, and it so happened that the subject taken in hand was just the tree whose merits rendered it worthy of being handed down to posterity. Would that we could hope that even a tithe of the trees which fashion bids us plant at the present time would develop into such noble growth as the Lebanon cedar. If this tree had been planted in the same proportion as the Wellingtonia, we might in truth congratulate ourselves on the provision we had made for our heirs in the matter of ornamental planting. It would be folly to hope that the Wellingtonia will ever make an ornamental tree in the sense that the Lebanon cedar is; for while in its youth it is as formal as it can well be, it is, travelers tell us, absolutely ugly in its old age. The near relations of the Lebanon cedar from the Atlas and Himalayan Mountains, however, are receiving their due meed of attention from tree planters, particularly the Deodar, on account of the gracefulness of its adolescent stage. The Atlantic or Atlas cedar, the African representative of the Lebanon species, is no doubt the more valuable of the two, and far more suitable for our climate generally than the Deodar, which is a tree for particular localities only. There are numerous examples about the country of the Deodar having been planted in ill-judged positions, the consequence being an array of miserable starvelings.

According to the "Hortus Kewensis," compiled by Aiton, the date of the first planted cedar is 1683, though this must be incorrect, inasmuch as there are records of a tree which was planted at Bretby Park, in Yorkshire, in 1676. That the Lebanon cedar was not planted or even known in this country previous to that date may be inferred from the fact that no mention is made of it by Evelyn in his "Sylva," which appeared about the year 1664. Aiton's account was no doubt founded upon the celebrated trees in the Apothecaries' Garden at Chelsea, planted in 1683, and which were supposed to have been the first planted in the country, and probably in Europe. Though Evelyn does not mention it in his "Sylva," he is, according to Loudon, supposed to be the introducer of it into Europe. In tracing out the modern or garden history of the Lebanon cedar, Loudon has compiled in his "Arboretum" a long account concerning the earliest planted trees, which embodies many interesting little incidents in connection therewith.

He says that there were cedar trees at Enfield and Hendon which were said to have been planted by Queen Elizabeth, but there seem to be no authentic memoranda in corroboration of this assertion. There can be no doubt that the cedar which may be seen to-day in the Chelsea Botanic Garden was among the earliest, if not the first planted, specimens. It is now a decrepit old tree, making a hard struggle with its greatest enemy, the polluted atmosphere of the great city. Though the epithet "magnificent" cannot now be applied to the tree, it is picturesque and interesting as a relic of departed grandeur. It would, however, cut a very sorry figure beside the noble specimens at Goodwood and Warwick. Contemporary with the Chelsea planted cedars are those, no doubt, at Syon, Gunnersbury, Kew, and Chiswick, all of which still exist. There were also some famous trees years ago at Whitton, then the residence of the Duke of Argyll—the treemonger as he was then called—who appears to have also planted the first cedars in Scotland at Hopetoun House, but the date of this planting seems to have been several years later than the trees planted about London.

It was not until about the year 1734 that the Lebanon cedar found its way into France; the first pair planted there were taken from England by Bernard de Jussieu. One was planted in the Jardin des Plantes. It is this identical tree that the accompanying engraving represents. It was one of the two which M. De Jussieu took with him, and both were so small that he is said to have carried them in the crown of his hat for safety. The tree planted on the mount in the Jardin des Plantes was measured about a hundred years after it was planted, and was found to be 10 feet in girth. The companion tree, planted at Montigny, near Montereau, is said to have grown into a far finer tree than that in the Jardin des Plantes.

One of the principal reasons, no doubt, why this cedar is not more generally planted nowadays may be attributed to the fact that it has the reputation of being a slow grower, and consequently years elapse before the tree assumes its true character. It need hardly be said that a tree possessing such a reputation at the present day, when trees that will not produce immediate effect are scrupulously shunned, stands but a poor chance of being plentifully planted. That the cedar is not, however, an exceptionally slow grower there is abundant evidence, and no one of late years has so clearly refuted the assertion as that veteran tree planter, Mr. Marnock, who gave some time since a detailed account of the rapid growth that this cedar had made at Greenlands, Henley on Thames, where within less than a lifetime there have grown up some noble trees. Planted in good soil on well-prepared sites, this cedar is without doubt as rapid a grower as the generality of conifers. It is to be regretted that Mr. Frost had not planted Lebanon cedars at Dropmore in his early days, and nurtured them with the same attention that he has the numerous other conifers under his care. These would have afforded valuable examples of the rate of growth of this cedar. Had this cedar been started on equal terms with the Deodar, Douglas Fir, and Araucaria, it would no doubt have developed as fine growth.—*W. Goldring, The Garden.*

THE FIRST CEDAR OF LEBANON PLANTED IN FRANCE, BY M. DE JUSSIEU IN THE JARDIN DES PLANTES IN 1734.

[Boston Advertiser.]

THE SEED TRADE.

There is a great commercial establishment in this town (Reading, Eng.), world famous and worthy a visit. It is truly a graphic illustration of what great results from little causes spring. This is the establishment of Messrs. Sutton, seed merchants. Theirs is a very peculiar trade, indeed unique in its way, for the seed trade as now known was really formed by Messrs. Sutton, of Reading, and all other seed businesses throughout the world are but imitations of their great establishment. Like all such matters, it also grew up from small beginnings, but its growth was rapid. Half a century ago the father and grandfather of the present partners were engaged in a corn dealing and milling trade. The seed business was founded by Mr. Martin Hope Sutton, the present senior partner. Among the causes that have contributed so rapidly to raise a small trade to the present commercial prosperity, none has been more powerful than the crusade waged by Messrs. Sutton against the abominable and too prevalent practice of seed adulteration. It is a matter of notoriety that it was a common custom (which indeed in some quarters still obtains) to reduce the germinating quality of seeds by the introduction of dead or useless grains in a fixed proportion. The certainty that has been acquired that the firm of Sutton not only send out unadulterated seeds, but seeds of proved growth, has given them that world wide fame which causes men in all parts of the earth to say: "If you want good seeds, go to Sutton's, of Reading." Ably piloted by a member of the firm, I recently enjoyed the rare privilege of visiting the huge fabric, and I cannot sufficiently thank the gentleman for the courtesy with which he showed me over the large place or the patience he displayed in explaining every, even the smallest, detail. Many hours can indeed be passed here most agreeably, and it is surprising how much there is that is new and interesting in connection with a mere seed.

The busy time of the firm is from January to April, and the rest of the year is chiefly spent in preparing for those months. In the autumn, however, there is a brisk demand for bulbs. Now, this is one of the peculiarities of this trade, that orders do not come in at the rate of so many a day, but in a series of great throbs, everybody seeming to want their seeds at the same moment, so that often the rush is literally overwhelming, and taxes to the utmost the resources and ingenuities of the establishment. The greater quantity of Sutton's seeds and bulbs are grown on their own farms, of which they have many in England, Germany, Holland, and the Channel Islands; but even with the knowledge that the seeds are grown from good stock the partners do not rest satisfied. Of the purity and value of a seed little idea can be formed, even by the closest examination of the sample. Hence it is necessary to subject it to trial, and no part of the establishment is more attractive or gives a greater idea of Messrs. Sutton's care than the seed trial house. Here a sample from every parcel of seed received on the premises is carefully tested, 50 or 100 seeds being taken indiscriminately out of the bag and sown. A careful record is kept of the percentage of growth, and not a seed allowed to go out of the house till the firm is satisfied that it will produce a good result in the hands of their customers.

Some of these seeds are grown in soil, others on bricks placed in a water-filled tank. All are subjected to heat, that they may sprout as quickly as possible. If a customer is, however, in a great hurry, a special arrangement is adopted. In a box heated with petroleum are placed layers of damp felt, and on this again are laid sheets of white blotting paper. Between these are strewn the seeds, and within 24, or at most 36, hours they come out enough to test their vitality. If they show themselves good under these abnormal conditions, Messrs. Sutton rest satisfied that they will be yet better when placed in soil. It would appear that at first they could not get all seeds to submit to this artificial process of growth. For example, lettuce was obdurate. They could not induce it to sprout, until at last they discovered that by dampening the seed itself before placing it on the damp felt, even its obduracy could be overcome. Of all these experiments, an elaborate register is kept. Hence, if customers should complain of the article delivered, the firm can refer to what the same seeds have done at their hands, and so find out what fault has been committed by the grower that he has not attained the same results. Often, of course, natural causes are to blame, like drought; often also the ignorance of growers as to treatment and soil. To obviate this as far as may be, Messrs. Sutton have long made it a rule to advise gratuitously their several customers in the matter of grass seed, as to which kinds are best suited to the particular land under cultivation.

A special room is set apart for testing and examining the specimens of soil sent up for this purpose. The expediency of the plan is obvious when it is remembered that, to enumerate only the leading descriptions, surface soils include such varieties as clay, heavy, light, and medium loams, chalky sheepdowns, chalky uplands, water meadows, and drifting and blowing sands, the characteristics of each of which are largely modified by the geological formation below. Each of these lands requires different treatment, and the grass that would thrive on one soil will not even grow on another. To ignorance on these points are due more failures in farming than to wet seasons or agricultural depression. Wise farmers consult Messrs. Sutton. They even leave it in their hands to decide what length of time pasturage shall occupy the ground, whether permanently or for a certain number of years, and by repeated and crucial tests Messrs. Sutton have now proved that it is possible in two or three years to produce a fine and permanent pasturage, a fact hitherto doubted by agriculturists, that most benighted, and as a natural consequence most conservative, among the races of mankind. Indeed, grass seed is one of Messrs. Sutton's strongest points; a special block of buildings is devoted to it, and very impressive are the huge rooms stocked full of thousands of bags of lawn mixtures and farm grass seeds. Here natural grass seeds grown in the best districts of the Rhine and Moselle, Scotch rye grass from the fertile land of Midlothian, clover seeds from almost every county in England, give some idea of the magnitude of the quantities required to meet the demands of customers. In this block too are the mixing floors, where are prepared the seed mixtures according to the particular soil and purpose for which they are wanted. When preparing grass seeds it seems it is always necessary to put the lightest at the bottom, or they can never be well mixed. When sending out lawn mixtures, the grass and clover have to be packed in separate parcels, as the clover, being the heaver, is apt to shake to the bottom during carriage by rail, and this class of customers usually sow straight out of the bag without thought, and, when only half the crop comes up, complain and say the seed was bad. This is but one instance among many of how Messrs. Sutton have to be wide awake to all the possible stupidities that may be committed by their clients. Thus another example. They have a special kind of flower, of which the seed costs £1,000 an ounce, and three seeds from 2s. 6d. to 5s. Customers usually take three seeds, which are supplied to them by letter. These they tear open so carelessly that the seeds roll out, and then they write to complain that they have never been received. The firm now gum them securely into the paper.

Of grass seed mixtures there are no less than 54 different kinds, all of which are prepared separately. The prescription for each is recorded in a book, together with the prescriptions of those made for special purposes, such as sowing down the grounds of the international exhibitions of Paris, Vienna, Philadelphia, and Melbourne, the race course at Gibraltar, the cricket ground of Malta, or some of the extensive

sheep runs of New Zealand. It is curious to learn that red clover and cow grass seed are so much alike that even the most experienced eye cannot tell them apart. Hence the former is kept in a locked room to prevent mistakes occurring, and entrance is only accorded by special order. This makes the assistants careful, and practically renders errors impossible.

What adds a charm to a visit to Messrs. Sutton is, besides the cleanliness of the stock in trade, the almost total absence of noisy and odoriferous machinery. With the exception of lifts, there is only one set of machines employed in the place, and these are neither large, noisy, nor fiendish of aspect. They are used for cleaning the seeds, and are known by the men respectively as "coercion" and "persuasion." The latter gently fans the seeds placed in it through seven different layers, until at last the best and heaviest fall to the bottom, the middle qualities having meanwhile stayed half way, and the dust flown out of the window. "Coercion" is employed upon wheat and larger seeds, the qualities being separated from each other by quick, sharp taps, not quite uniform in character, while the rubbish falls through sieves placed beneath. The best quality is then sold as A, the second as B. Formerly the third quality was carted away from the place as rubbish and shunted over the nearest railway embankment. My guide told me, however, that competition was so great now in the seed department that this third quality is sent to London, where it is sold at Mark Lane for a low price, not, however, of course, under the name or ægis of Messrs. Sutton. "People wonder then," he went on to say, "that the crop raised thence is worthless, if indeed there is a crop at all. They have just bought cheap, have crowded over those customers who buy of us and pay what seem high prices, and have never calculated the consequence." Some grass seeds are of too light a character to be cleaned thus, and have to be hand sifted. Hand sifted, too, are peas and beans, as it is with them not so much a question of weight as of appearance, whether they be good or no. A long room is devoted to the sorting of these, where women sit in rows before counters spread with the round fruits. Those that are good are sent rolling through a hole in the counter, under which is placed a sack; those that are indifferent or bad are thrown away. These women are paid by an ingenious system that makes it to their profit to pick out only the best and to reject any that have the least blemish or flaw.

Flower seeds and bulbs have also three separate departments. These are obtained from plants grown, ripened, and harvested on Messrs. Sutton's own grounds, and include all varieties, from the modest mignonnette, at sixpence an ounce, to the highly bred and developed begonia, at £200 an ounce. During the various periods of growth, plants that have been put out for seed are carefully inspected at intervals by one of the firm, and every "rogue" or untrue plant is taken out. Bulbs require much care, as they are apt to sprout or become mildewed. In the bulb room an equable temperature and perfect ventilation are needful. It is further divided into compartments, with sliding wooden doors. Besides this, every separate lot of bulbs is kept in a large basket of light wicker work, which admits air all around; and in the center, passing through the mass of bulbs, is a tube of iron wire netting which again brings air into the very center of the mass. One result of this care and treatment is to favor a dry dormant condition; the bulk of every parcel is such that exhaustive evaporation is prevented, while on the other hand the bulbs are kept so cool and airy that they are most reluctant to grow, and hence when planted or potted they have all their initial vigor well preserved.

But, after grasses, vegetables are, perhaps, Messrs. Sutton's strongest point. We have all of us, at agricultural shows, seen the cases they exhibit with mammoth cabbages, peas, beans, potatoes, and what not else, all professedly grown from their own seeds, and have often, I dare say, felt a little doubtful as to the absolute fidelity of these representations. It was a reproof to such incredulity to be taken into the modeling rooms, where these features are prepared for exhibition, and to see the workmen modeling cabbages, leaf by leaf, from the original, casting potatoes, carefully reproducing turnips and swedes. Indeed, it is quite a large department, this modeling one. Of their vegetable seeds the firm are very properly proud, for to bring them to their present perfection has needed years of research and observation. In the first instance stock seed is obtained. This is acquired somewhat in the following fashion. Take wheat for example. It is well known that the grains in an ear that sit at the top and bottom are less strong than those in the middle. Hence Messrs. Sutton would only take for stock the middle grains. From these they would raise a crop, again taking only the middle grains for stock, and so on for several years, until a most superior strong stock seed is obtained. One room is wholly devoted to beet stock, obtained in this wise. This, my guide told me, was the most valuable stock upon the premises, having a pedigree 20 years old. It is one of the most difficult to obtain, for a splendid crop of beet may be growing, and the whole spoiled by a swarm of bees flying over a neighboring field of mangel and producing cross fertilization. In this way the labor of years can be rendered nil; and the whole process of raising a strong stock must be gone through again.

It seems strange, at the first blush, that seeds should require it, but one room is set apart for the records of the pedigrees of all seeds that have ever passed through the premises. Whenever it is possible, Messrs. Sutton also like to keep acquainted with the subsequent history of their seeds. Thus, when some of them go out to farmers whom they know and can trust, they often ask permission to visit the crop and select fine specimens for seeding again. For example, with swedes, they know a man who grows them well, and they arrange with him annually that they should select from his field say 400 specimens, perfect for size, rootlessness, color, and shape. These they plant again, submitting them to yet a second or even third process of selection, until at last those wondrous samples are obtained that we see in their show cases. The whole matter, after all, is only the Darwinian process of natural selection and the survival of the fittest artificially brought about. Potatoes are another of the strong points of the firm, and the varieties sent out by them are known for their disease resisting powers. These are also sorted by hand in a room with a good strong upper light that would bring into relief any imperfection. Of course, all manner of dangers have to be guarded against. Thus, mushroom spawn has to be inclosed in a dark room and requires much care, or it will run into white filaments. Turnip seeds are apt to develop a mite like to that in cheese. They have, therefore, to be kept in a room at a temperature not likely to germinate the little nuisances, but even so they will often spring into life. Hence, every now and then a sack of turnip seed is blown out by passing it through "persuasion." Else the mite would eat into the seeds and kill their power of vitality.

An entire building is devoted to the export trade and the drying and packing connected with this. It is by their original process of packing that Messrs. Sutton have got the chief colonial trade in their hands, for by this means the seeds do not suffer from the changes of climate to which they are subjected. The actual method of packing is a trade secret. The receptacles in which they are packed vary from tin boxes air tight and specially made for the purpose, and which are finally soldered down, to iron tanks and enormous zinc lined wooden cases. There are special drying rooms for seeds that have to go through the Suez Canal. The purpose is to dry out the damp that is naturally around a seed. If this were not done, when going into hot countries the damp would evaporate, settle on the tins, and cause the contents to germinate or "malt." This drying, must, however, be done with extreme care, so as to dry and yet not to kill by withdrawing the moisture needful to maintain vitality. Even for the smallest order from abroad the stoves are set alight; the firm do not wait until they have a considerable quantity ready. Large consignments are dried in sacks, laid upon a perforated iron floor; smaller, in iron baskets put on stands. Of course this drying somewhat reduces the weight of each parcel, at the rate of six pounds a hundredweight. It is, therefore, an understood thing with colonial customers that they pay 21½ hundredweight for a ton of goods, 1½ hundredweight being lost by evaporation.

By no means inconsiderable are the ledger, dispatch, railway, and post offices of the firm, their business of this kind being the more extensive that Messrs. Sutton have no agents, but require all orders to be sent to them direct. In this way they can insure that only genuine goods go out under their name. I was shown a packet of one day's orders, a goodly pile, truly, and this did not include letters, correspondence, invoices, etc. Of the former about 1800 are received daily, and some 700 parcels of seeds dispatched. By a careful system of bookkeeping, known as dissecting, Messrs. Sutton can, at a moment's notice, find out how much profit they have made upon every kind of seed. Altogether, the arrangements in each department of this huge concern are perfect in their way. That Messrs. Sutton have rendered real services to horticulture and agriculture it does not need their goodly display of prize medals from every state in the world to testify.

HELEN ZIMMERN.

ORANGE AND LEMON CULTIVATION IN SICILY.

CONSUL WOODCOCK, of Catania, states that oranges and lemons are designated, in Sicily, *marina* and *montano*, the former growing in the lower altitudes near the sea, and the latter on the mountains. The montano, or mountain fruit, is the choicest, and commands the best prices in the market, but the crop is not so sure, owing to the frost. The marina orchards bear more abundantly, and the crop is more certain. In commencing an orange or lemon orchard, the following is the method adopted: First, the seed of the bitter orange is planted, and when the young plants are a year old, they are transplanted. When they have grown to be about one inch in diameter, that is, when they have attained the age of three to four years, they are again transplanted, and placed in the orchard where they are intended to remain. The tops of the young trees are then cut off about four feet above the ground, and when they have taken firm root, the best varieties of the orange and lemon are budded upon the stock. Two buds are generally inserted, and upon opposite sides of the plant. From these buds, branches shoot out, and when a quarter of an inch in thickness, become of a reddish color. The distance to be maintained between the lemon trees in the orchards depends upon the situation of the ground, and conditions of soil and climate; usually it varies from thirteen to nineteen feet. When the soil is loose, rich, and easily cultivated, the lemon trees are planted at least nineteen feet apart, as they will then grow luxuriantly and attain considerable size. The distance maintained between the orange trees is from thirteen to fourteen feet, and this varies in accordance with the situation and quality of the soil, as in the case of the lemon. The ground in the orchards between the trees is always cultivated, and great care is taken to keep it scrupulously clean.

The soil is worked at least five times a year, commencing in March and ending in October. When the trees are young and small it is not considered necessary to work the soil, as it is believed that the vegetable growth protects the young plants from the too powerful rays of the sun. The annual cost of cultivation in the best orchards per hectare (the hectare being equivalent to 2·47 acres) is estimated at about £30, but where extraordinary outlays are necessary, such, for instance, as is incurred when there are streets running through the orchards, as is often the case in the lava covered soil of Sicily, or through the necessity of obtaining steam power for irrigation, the cost per annum is sometimes as much as £80 per hectare. On the average, a lemon tree produces in Sicily one thousand lemons annually, and an orange tree six hundred oranges, and cases have been known where trees have produced ten times this amount of fruit. The trees are subject to various diseases. A parasite growth of a fungus nature frequently appears upon the bark, and the lemon tree is more subject to this than the orange. This growth, after a heavy rain, or after being soaked in water, can be removed by scraping. The fruit of both the orange and lemon trees is also sometimes injured by a small insect which makes its appearance at the beginning of summer, and commences its work of devastation by depositing its eggs in the fruit itself, and these develop into grubs, which entirely destroy it. As a preventive, tar water and water, slightly tinctured with kerosene, are used to wash the leaves and fruit, and soda ash is also frequently employed. In picking the fruit for exportation, which is usually done by hand in the month of November, the greatest care is taken to avoid bruising or injuring it in any way by rough handling, and it is then placed very gently in baskets lined with cloth. The stem is left on the fruit, cutting it about a quarter of an inch from the surface of the fruit. Before placing the fruit in the boxes, all insects and other injurious matter are removed. The boxes generally used are capable of holding from two hundred and fifty to three hundred and sixty oranges or lemons, and are made with a partition in the center. They are lined with common silk paper, and each orange or lemon is incased in the same kind of paper before being placed in them. The boxes are not made air tight, but interstices are left between the boards for ventilation. Lemons gathered in the month of November, and thus packed, are supposed to keep without spoiling for six months, but oranges will not keep so long.

TABLE OF CONTENTS.
